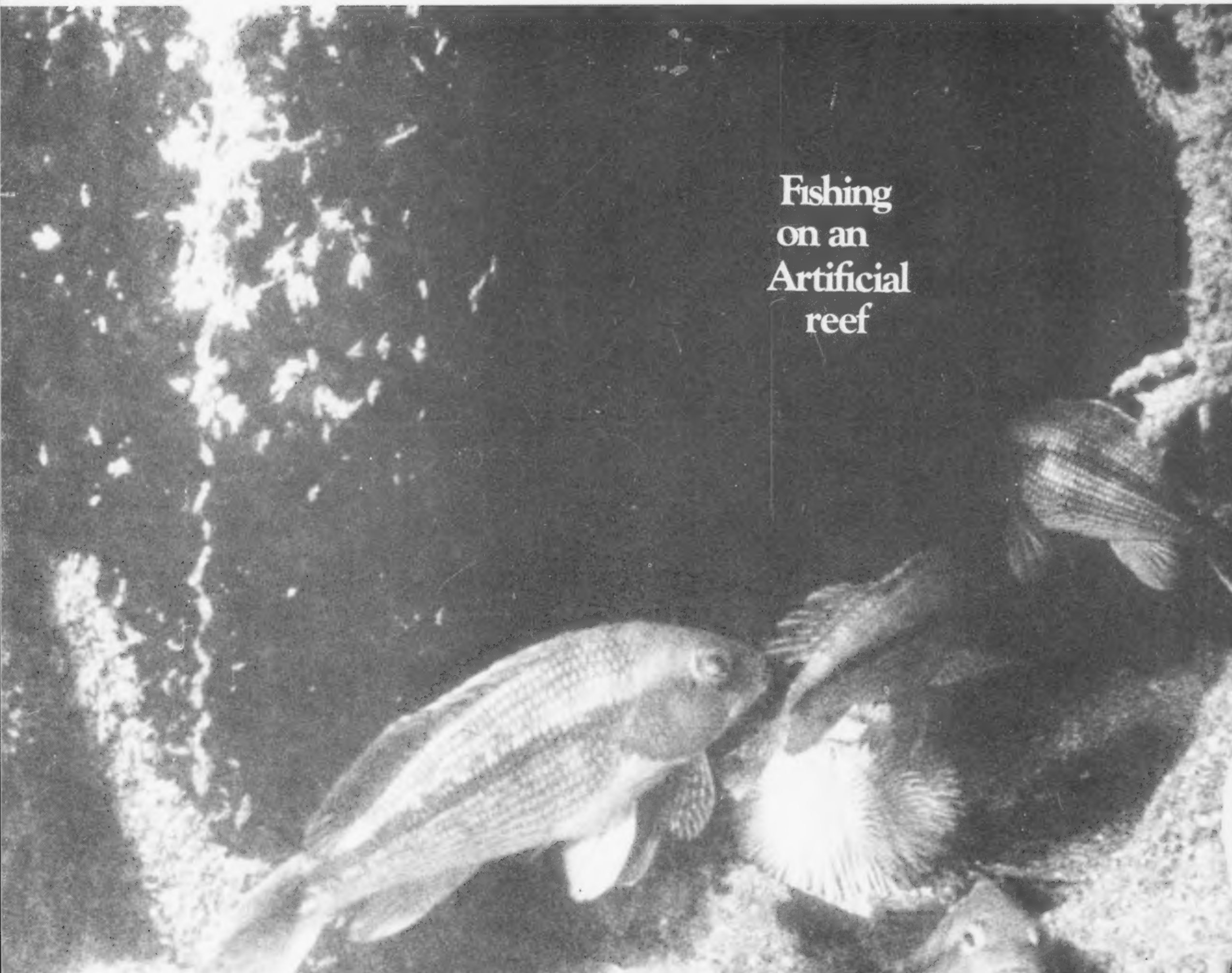
November 1974 Volume 36 Number 11

Marine Fisheries REVIEW

National Oceanic and Atmospheric Administration • National Marine Fisheries Service



U.S. DEPARTMENT OF COMMERCE
Frederick B. Dent, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Robert M. White, Administrator

National Marine Fisheries Service
Robert W. Schoning, Director

Address correspondence to: Marine Fisheries Review, NMFS Scientific Publications Staff, Room 450, 1107 N.E. 45th St., Seattle, WA 98105.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director, Office of Management and Budget, May 10, 1973.

Editor: Thomas A. Manar

Managing Editor: Willis L. Hobart

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price $1.25 (single copy). Subscription price: $12.50 a year, $15.75 a year for foreign mailing.

Marine Fisheries Review

Vol. 36, No. 11
November 1974

CONTENTS

Articles

Departments

Cover.—Black sea bass using Paradise Artificial Reef, off the coast of South Carolina, as an area of protection and food during their period of peak abundance (see article starting on page 32).

MFR PAPER 1098

Korea has its eyes set on becoming the fifth largest fishing nation by 1976.

Fisheries of the Republic of Korea

WILLIAM B. FOLSOM

AUTHOR'S NOTE

The statistics used in this report were taken from the Republic of Korea's Office of Fisheries publication, *Yearbook of Fisheries Statistics, 1973* (with data for 1972). These statistics are generally quite accurate, but occasionally the rounding of some figures resulted in totals which are either smaller or larger than the actual sum of the supporting data. There are also a few miscalculations in certain tables and, because of conflicts with other sources, a correct answer was not always available. As a result, it was sometimes necessary to rely exclusively upon the *Yearbook of Fisheries Statistics, 1973*, since it is the official statistical source for ROK fisheries.

For general background information, the Office of Fisheries publication *Current Fisheries in Korea, 1972* (with data for 1971) was used heavily. Korean and Japanese newspaper reports along with U.S. Embassy reports supplied additional material. In addition, the Republic of Korea's Fisheries Attache in Washington, D.C., Kim Han Mo, provided guidance and information not available elsewhere. His assistance is gratefully acknowledged.

INTRODUCTION

The year 1972 was exceptionally good for the fishermen of the Republic of Korea (ROK). First, they made a record harvest of 1,343,569 metric tons: 20 percent more than the 1,073,733 metric tons caught in 1971 and considerably more than the 1,096,252 metric tons called for in Korea's Third 5-Year Economic Development Plan. Secondly, this catch represented a threefold increase in production over the 470,187 metric tons caught in 1962—a remarkable rate of growth for any nation's fisheries. Third, the 1972 catch was worth US $270 million, 5 percent more than the 1971 catch, which was worth $256 million. Fourth, Korean processors produced 161,846 metric tons of seafood products, 38,429 metric tons more than the 123,417 produced in 1971. Fifth, exports of ROK fishery products were 187,300 metric tons (146,394 in 1971) worth $152 million (versus $114 million in 1971). Thus Korea's fisheries not only helped to feed the population, but were also an important source of foreign currency.

The year 1972 was important for other reasons as well. The catch capacity of the ROK high-seas trawler fleet was increased considerably by the addition of several ultramodern stern trawlers and the tuna fleet grew rapidly in number. In 1972, ROK high-seas fishermen fished in three oceans, operated out of 18 foreign ports, and helped man over 455 deep-sea vessels registering 159,290 Gross Registered Tons (GRT). By contrast, in 1961 there was only one tuna vessel in the entire South Korean high-seas fishing fleet. South Korea's coastal fishermen also had reason to be proud. In 1972 these fishermen increased their production by more than 20 percent over 1971. Rapid progress was also made in the shallow-sea aquaculture program during the year. Also, Korea's inland fishermen had modest gains. Only the whaling industry and the inland, freshwater culture industries suffered setbacks during 1972.

William B. Folsom is with the Office of International Fisheries, National Marine Fisheries Service, NOAA, Washington, DC 20235.

Throughout the ROK fishing industry far-reaching efforts have been made—and more are planned—to expand, modernize, train, and equip the nation's fishing industries and fishermen. This effort, applied for over a decade and projected into the coming decade, has helped to make Korea one of the world's most dynamic fishing nations.

CATCH STATISTICS

Despite tremendous obstacles—World War II, the Korean War, and the resulting economic dislocations—the Koreans have struggled tenaciously to expand their fishery. Table 1 and Figure 1 show the growth of this nation's fisheries since 1944.

Almost 99 percent of Korea's catch comes from that nation's saltwater fisheries: in 1972 the marine catch was 1,342,411 metric tons compared with 1,158 metric tons (1 percent) from the nation's freshwater fisheries.

The ROK coastal fisheries are the most productive. In 1972 these fisheries provided 71 percent of the entire catch, followed by the high-seas fisheries with 16 percent, the shallow-sea aquaculture program with 12 percent, and the inland fisheries and whaling with only 1 percent of the total catch. Table 2 gives a breakdown of the ROK catch, by each fishery, for the period 1962-72.

In 1972 fish accounted for 71 percent of the entire catch (947,661 metric tons), followed by mollusks (17 percent or 231,475 metric tons), seaweed (10 percent or 128,830 metric tons), crustaceans (slightly over 1 percent or 23,423 metric tons), and "other" marine species (slightly under 1 percent or 12,180 metric tons).

Alaska pollock became the ROK's most abundant species in 1972 with a total coastal and high-seas catch of 148,453 metric tons. Hairtails took second place (110,309 metric tons), followed by anchovy (104,174 metric tons), mackerel (90,416 metric tons), tuna (84,151 metric tons), oysters (72,708 metric tons), dulse (58,151

Table 1.—Republic of Korea's fisheries catch, 1944-72.

Year	Quantity
	Metric tons
1972	1,343,569
1971	1,073,733
1970	935,462
1969	862,784
1968	852,291
1967	750,349
1966	702,295
1965	636,512
1964	599,824
1963	532,153
1962	470,187
1961	447,634
1960	357,181
1959	392,060
1958	403,304
1957	409,309
1956	346,561
1955	265,895
1954	254,642
1953	266,995
1952	281,849
1951	266,849
1950	219,450
1949	290,204
1948	289,147
1947	301,952
1946	296,346
1945	228,188
1944	295,747

SOURCES: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973* (for the period 1950-72) and Fisheries Research and Development Agency, Statistics of Fisheries Catches, 1961.

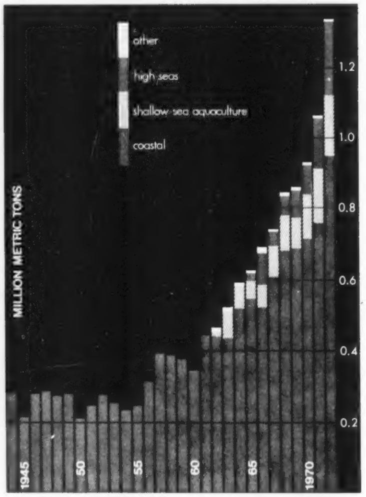


Figure 1.—Republic of Korea's fisheries catch, 1944-72.

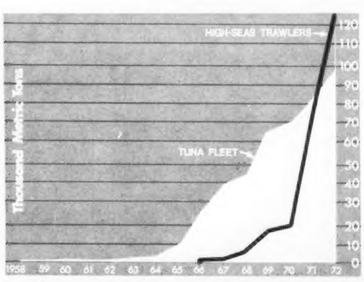


Figure 2.—Republic of Korea's high-seas catch by tuna fleet and high-seas trawler fleet, 1958-72.

Table 2.—Republic of Korea's catch, by type of fishery, 1962-72.

Year	Marine fisheries: High seas	Marine fisheries: Whaling	Marine fisheries: Coastal	Marine fisheries: Aquaculture	Total marine	Inland fisheries: Fisheries	Inland fisheries: Culture	Total inland	Grand total
					Metric tons				
1972	224,135	1,622	958,276	160,378	1,342,411	1,103	55	1,158	1,343,569
1971	159,307	2,155	764,179	147,221	1,072,862	696	174	871	1,073,733
1970	89,621	1,866	724,365	119,211	935,064	381	17	398	935,462
1969	82,782	1,322	691,348	86,316	861,768	895	120	1,015	862,784
1968	50,074	1,044	687,034	113,031	851,183	1,086	22	1,108	852,291
1967	40,484	1,140	610,707	97,131	749,462	854	33	887	750,349
1966	26,852	1,128	528,893	91,060	701,933	337	25	362	702,295
1965	8,563	860	553,070	73,675	636,168	314	30	344	636,512
1964	2,605	2,801	519,459	72,885	597,750	2,035	39	2,074	599,824
1963	2,558	1,710	441,638	85,285	531,191	923	39	962	532,153
1962	657	1,778	448,117	18,709	469,261	895	31	926	470,187

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea.
Note: Because of rounding of data, totals do not necessarily agree.

Table 3.—Republic of Korea's high-seas catch, by fishery, 1958-72.

Year	Catch by fishery: Tuna longline	Catch by fishery: Trawl	Catch by fishery: Other	Total catch
		Metric tons		
1972	97,670	126,465	—	224,135
1971	83,784	75,523	—	159,307
1970	71,363	18,258	—	89,621
1969	66,637	16,145	—	82,782
1968	43,519	6,555	—	50,074
1967	38,334	2,024	126	40,484
1966	25,473	1,379	—	26,852
1965	8,563	—	—	8,563
1964	2,605	—	—	2,605
1963	2,558	—	—	2,558
1962	657	—	—	657
1961	367	—	—	367
1960	914	—	—	914
1959	538	—	—	538
1958	257	—	—	257

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea.

metric tons), squid (57,239 metric tons), corvenia (45,376 metric tons), and saury (38,544 metric tons). These 10 fisheries alone account for 60 percent of the entire ROK catch.

HIGH-SEAS CATCH

In 1972 a total of 455 high-seas vessels—longliners, stern trawlers, otter trawlers, shrimpers, gillnetters—registering 159,290 GRT caught 224,135 metric tons of fish, crustaceans, and mollusks. This was a 29 percent increase over the 1971 high-seas catch of 159,307 metric tons and accounts for 16 percent of the entire

Table 4.—Republic of Korea's high-seas trawler fleet catch, by species and by ocean, 1962-72.

Species / Ocean	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
					Metric tons						
North Pacific:											
Alaska pollock	107,961	60,086									
Bastard halibut	7	470									
Cod	245	571									
Flounder	1,665	85									
Octopus	—	2,159									
Seabream	8	45									
Shrimp	185	72									
Squid	451	429									
Other	611	4,674									
Total	117,138	68,591	12,708	15,137	2,471	—	—	—	—	—	—
Atlantic:											
Bastard halibut	26	135									
Cod	9	—									
Flounder	226	132									
Octopus	1,230	1,695									
Seabream	1,819	472									
Shrimp	133	34									
Squid	4,039	2,377									
Other	1,845	2,087									
Total	9,327	6,932	5,550	1,008	809	2,007	1,379	—	—	—	—
East China Sea	—	—	—	—	731	—	—	—	—	—	—
Indonesian waters	—	—	—	—	2,544	17	—	—	—	—	—
Total:											
Alaska pollock	107,961	60,086									
Bastard halibut	33	605									
Cod	254	571									
Flounder	1,891	217									
Octopus	1,230	3,854									
Seabream	1,827	517									
Shrimp	318	106									
Squid	4,490	2,806									
Other	8,461	6,761									
Total	126,465	75,523	18,258	16,258	6,555	2,024	1,379	—	—	—	—

SOURCES: Office of Fisheries, *Yearbook(s) of Fisheries Statistics, 1973 (and 1972)*, Republic of Korea.

South Korean catch. Table 3 provides catch statistics for the high-seas fleet for the period 1958-72, and Figure 2 graphically illustrates this growth.

Trawl Fleet Catch

The 95-vessel ROK high-seas trawl fleet caught 126,465 metric tons of fish in 1972 versus 75,523 metric tons in 1971. This is 60 percent of the total high-seas catch, and it marks a turning point in the ROK high-seas fisheries, because the tuna fleets had traditionally outfished the trawl fleets. Much of the increase in the trawl catch was due to the introduction of several new stern trawlers into the Alaska pollock fisheries in 1971-72 and to the growing professionalism and experience of South Korean crewmen aboard these vessels.

Most of the ROK trawl catch was made in the North Pacific, and Alaska pollock was the principal species caught—107,961 metric tons out of a total catch of 117,138 metric tons. ROK trawlers also fished in the waters off Northern Hokkaido and Kamchatka, and others fished for squid, octopus, and seabream from bases in the Atlantic Ocean. Table 4 provides catch statistics for 1966-72.

Tuna Fleet Catch

The ROK high-seas tuna fleet also increased production from 83,784 metric tons in 1971 to 97,670 metric tons in 1972 (Table 5), but the increase was not enough to match the dramatic catches made by the trawler fleets. In terms of value, however, the tuna catch was worth $59.7 million while the larger trawl catch was worth only $21.8 million.

In 1972, the best area for the Korean tuna fleets was the Pacific Ocean where 40,358 metric tons were caught; albacore and yellowfin tuna were the most abundant species. The catch in the Atlantic Ocean dropped slightly in 1972 from 37,142 metric tons to 36,345 metric tons, despite increased catches of albacore and yellowfin tuna. The catch in the Indian Ocean increased to 20,967 metric tons—slightly over the 1971 catch.

Albacore was the principal species caught: 32,757 metric tons were landed—narrowly above the 32,436 metric tons of yellowfin tuna caught by the South Koreans in 1971. The catches of all other species except bluefin tuna also increased during 1972. Bluefin tuna dropped from 6,514 metric tons in 1971 to a mere 582 metric tons in 1972. This drop in

Table 5.—Republic of Korea's high-seas tuna longline fleet catch of tuna and allied species, by species and by oceans, 1962-72.

Species / Oceans	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
	Metric tons										
PACIFIC OCEAN:											
Tunas:											
Albacore	15,579	12,504									
Bigeye	7,801	4,665									
Bluefin	480	3,226									
Skipjack	452	154									
Yellowfin	11,778	5,328									
Other:											
Marlin	1,902	589									
Sharks	83	51									
Other	2,283	3,339									
Total	40,358	29,856	27,690	35,431	19,299	19,030	17,598	8,043	2,438	2,558	657
ATLANTIC OCEAN:											
Tunas:											
Albacore	13,577	11,539									
Bigeye	5,730	7,353									
Bluefin	30	3,039									
Skipjack	45	47									
Yellowfin	11,078	9,901									
Other:											
Marlin	1,714	780									
Shark	609	405									
Other	3,562	4,078									
Total	36,345	37,142	34,865	12,594	12,624	12,836	7,114	520	167	—	—
INDIAN OCEAN:											
Tunas:											
Albacore	3,601	2,108									
Bigeye	4,337	4,059									
Bluefin	72	537									
Skipjack	11	23									
Yellowfin	9,580	6,454									
Other:											
Marlin	1,151	719									
Shark	371	352									
Other	1,844	2,534									
Total	20,967	16,786	8,808	18,612	11,596	6,594	761	—	—	—	—
TOTAL CATCH:											
Tunas:											
Albacore	32,757	26,575									
Bigeye	17,868	16,097									
Bluefin	582	6,514									
Skipjack	508	222									
Yellowfin	32,436	21,702									
Other:											
Marlin	4,767	2,116									
Shark	1,063	808									
Other	7,689	9,750									
Total	97,670	83,784	71,363	66,637	43,519	38,460	25,473	8,563	2,605	2,558	657

NOTE: 1971 catch figures do not add correctly.

Table 6.—Republic of Korea's whale catch by number of individual whales and by quantity (metric tons), 1962-72

	Large whales		Small whales		Total whales	
Year	Number	Quantity	Number	Quantity	Number	Quantity
1972	753	1,585	16	37	769	1,622
1971	697	2,017	58	138	755	2,155
1970	606	1,623	134	244	740	1,866
1969	35	542	386	780	421	1,322
1968	28	472	316	572	344	1,044
1967	20	376	336	764	356	1,140
1966	14	215	309	913	323	1,128
1965	17	317	249	543	266	860
1964	88	1,816	384	985	472	2,801
1963	55	840	291	870	346	1,710
1962	82	1,353	170	425	252	1,778

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Korea.
NOTE: The designation "Large whales" includes fin, sei, minke, and other whales. The designation "Small whales" includes humpback whales, minke whales, and other whales. Apparently, minke whales fit into both categories depending only upon the size of the whale.

production may be attributable to overfishing in recent years; the Japanese have already agreed voluntarily to limit their catch of bluefin tuna.

WHALE CATCH

The Republic of Korea is not a member of the International Whaling Commission. Its whale catch continued to increase in 1972 (Table 6). The catch of whales rose from 755 individuals in 1971 to 769 individuals in 1972. Despite the increased numbers caught, the weight of the catch decreased from 2,155 metric tons in 1971 to 1,622 metric tons in 1972. This decrease in weight was due to a sharp drop in the average size of the "large" whales. Most of this catch is processed and then exported to Japan.

COASTAL CATCH

Korea's coastal waters have historically played a surprisingly important role in that nation's fisheries. A little more than a quarter of a century ago, for example, Korea was the world's third largest producer of fish! This feat was achieved in 1948, the year that the Republic of Korea was formally established under United Nations' auspices. In that year Korea (the northern and southern regions combined) caught 1,769,000 metric tons of fish, and almost all of this came from their coastal waters. In 1948, only Japan and the United States outfished Korea.

The Korean War, which erupted on 25 June 1950, divided this once unified nation into two bitter factions and left the southern half—the Republic of Korea—a war-torn land with few resources. With their economy shattered by three years of war the Koreans could only turn to the sea for national survival. Fortunately the Koreans were skilled fishermen, gifted with rich fishing grounds just off their shores.

The 600-mile-long Korean peninsula is surrounded by the ocean; no Korean lives more than 68 miles from the sea. The peninsula stretches down towards the East China Sea and is bounded on the east by the Sea of Japan and on the west by the Yellow Sea. Beyond the 9,325-mile coastline the warm waters of the Tsushima Current react with the cold waters of the Rimian Current to bring Korean fishermen a wide array of warm- and cold-water species in great abundance.

Figure 3 is a map of the Republic of Korea showing the location of many of that nation's fishing ports.

In 1972 South Korea's coastal fishing industry accounted for most of the ROK national catch; 71 percent of the catch or 966,272 metric tons versus 764,179 metric tons in 1971. This 20-percent increase is especially significant for modern South Korea for several reasons. First, pollution of coastal waters is slowly becoming a problem. Second, this fishery employs almost all of the nation's fishermen and their livelihood depends on the coastal catch. Third, 97 percent of the ROK fleet (about 66,000 vessels) are employed in this fishery and 80.5 percent of these vessels are unpowered, old, and not very efficient. Despite these difficulties the catch increased.

In 1972 fish accounted for 732,998 metric tons (573,608 metric tons in 1971) of the entire coastal catch, followed by mollusks with 114,834 metric tons (95,018 metric tons in 1971), seaweeds with 74,922 metric tons (68,364 metric tons), crustaceans 22,964 metric tons (15,279 metric tons), and "other" aquatic species (such as sea cucumbers and sea urchins) with 10,558 metric tons (versus 11,910 metric tons in 1971).

Table 7 gives a complete breakdown of the ROK coastal fisheries catch by species for the years 1962-72. A brief summary of the more important coastal species is provided below.

Hairtails: In 1962 the catch of hairtails in South Korea was 39,307

Figure 3.—Republic of Korea.

Table 7.—Republic of Korea's coastal fishery catch, by species, 1962-72.

Species	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
	Metric tons										
FISH:											
Alaska pollock	40,492	11,241	13,418	10,062	28,678	17,503	21,013	26,696	20,653	22,600	27,792
Anchovy	104,174	66,904	54,047	115,056	63,127	78,538	66,349	56,761	35,592	32,392	46,955
Bastard halibut	6,659	4,336	3,123	2,510	3,738	3,897	2,625	2,117	2,011	2,178	2,297
Cod	757	2,571	2,753	3,279	2,218	2,286	2,211	2,252	1,465	853	1,389
Corvenia:											
Yellow	25,352	24,554	31,765	30,447	45,392	35,680	44,543	39,608	47,018	23,049	21,653
Other	20,024	19,230	23,408	12,951	8,454	21,841	9,879	2,857	2,032	1,308	319
Croaker	997	967	1,597	1,142	2,526	2,150	2,840	3,163	4,174	3,358	2,943
Flathead	1,425	1,036	1,622	1,125	1,839	2,256	1,633	1,434	1,386	1,275	933
Flounder	19,113	18,633	21,648	20,133	19,758	16,457	12,021	13,495	10,252	11,410	8,639
Gurnards	26	98	273	121	274	497	621	700	28	89	81
Hairtails	110,309	82,868	69,082	47,922	18,592	48,713	45,384	37,683	29,961	30,451	39,307
Halfbeak	1,116	958	239	591	500	462	226	914	175	264	23
Herring:											
Big-eyed	4,941	3,107	3,479	2,600	3,705	2,831	1,558	2,554	2,395	1,910	1,255
Other	6,311	6,718	746	893	1,246	20	—	7	—	—	256
Hickory shad	4,354	5,205	7,861	3,761	5,083	3,493	3,803	1,877	1,953	3,786	2,602
Kangdali	11,939	3,760	5,904	2,429	1,279	—	—	—	2,649	3,974	1,794
Lizardfish	345	245	252	232	140	112	232	127	322	250	308
Mackerel:											
Horse	2,753	8,904	883	2,042	2,543	5,280	10,058	26,496	19,581	12,440	18,419
Spanish	8,694	6,584	5,276	3,367	5,126	7,581	7,590	5,608	4,465	2,956	3,432
Other	78,969	60,599	38,256	42,103	10,481	2,772	2,078	7,339	2,441	5,406	4,058
Marine eels:											
Sea	4,613	3,943	5,452	4,480	4,548	3,574	2,647	2,185	1,202	1,072	1,341
Shark-toothed	4,242	2,789	2,732	2,633	3,829	2,807	2,717	1,572	1,577	1,606	1,761
Other	—	—	—	321	—	—	—	—	1,856	2,007	2,128
Mullets	1,969	2,295	2,742	2,272	2,351	2,034	2,120	1,909	1,280	960	1,631
Pomfret	8,318	4,492	4,727	1,432	6,077	6,169	7,852	4,972	5,434	3,992	2,250
Puffer	3,046	3,127	4,096	5,691	5,229	4,241	3,150	6,262	—	—	—
Redfish	1,057	1,355	1,535	1,298	1,498	1,467	3,313	2,356	1,992	1,526	774
Rockfish	1,132	1,338	1,548	930	1,093	993	683	769	423	490	702
Salmon	382	226	83	153	34	42	64	166	59	27	37
Sandfish	9,961	24,809	16,110	9,854	13,606	7,118	6,242	9,098	2,659	2,439	5,751
Sandlance	2,434	497	7,038	6,275	4,464	3,890	2,311	1,029	6,461	2,100	6,691
Sardine	315	138	101	—	32	3	—	18	60	—	10
Saury	38,544	30,592	25,036	29,748	29,893	27,858	39,404	32,281	25,370	12,544	39,972
Sea bass:											
Common	321	263	438	437	492	549	584	368	366	516	460
Other	54	238	359	121	165	253	114	72	153	142	283
Seabream:											
Black	487	499	346	406	1,005	603	393	432	279	415	499
Red	1,796	967	792	856	1,806	1,460	1,445	1,118	2,235	1,032	1,651
Yellow	347	111	43	—	—	—	—	—	495	295	217
Other	599	433	693	506	911	921	695	515	50	82	119
Shark:											
Blue	4,951	4,753	5,743	8,852	2,105	2,251	786	3,696	37	580	77
Grey	279	276	778	—	1,085	844	429	—	—	—	—
Other	1,857	1,643	2,059	—	3,466	5,205	3,071	4,214	4,345	7,139	7,133
Skates & rays	9,918	7,172	7,691	9,116	11,299	9,179	9,471	8,574	8,211	7,414	7,637
Sole	2,703	2,945	2,568	1,693	2,235	2,623	2,600	1,985	2,092	2,213	2,554
Tuna	38	60	278	19	79	116	1	—	—	2	—
Whiting	928	1,772	777	1,432	65	39	33	219	967	596	1,124
Yellowtail	1,301	761	1,718	2,247	2,942	1,654	1,331	1,136	789	1,182	1,440
Other marine fish	182,656	147,551	124,948	119,398	135,029	101,793	75,570	67,942	61,660	38,832	26,846
TOTAL FISH	732,998	573,608	506,063	512,935	460,037	440,055	401,690	384,578	318,610	249,152	297,343
CRUSTACEANS:											
Crabs:											
Blue	5,701	4,113	2,700	1,279	2,483	2,121	1,550	—	—	—	—
Large	132	494	247	253	435	756	403	271	2,179	2,348	3,544
Other	3,120	3,167	2,404	1,141	1,430	1,224	1,235	4,469	—	—	—
Shrimp:											
Barley	810	571	95	78	—	—	—	—	—	—	—
Helmet	45	52	49	7	56	—	—	—	—	—	—
Large	704	266	457	230	2,301	3,097	1,406	1,992	1,358	696	559
Medium	846	906	606	1,031	1,007	1,281	1,072	1,189	1,485	1,281	1,162
Small	4,897	2,825	6,509	—	—	—	—	—	—	—	—
Other	2,813	1,626	2,981	5,404	8,044	16,595	9,637	14,014	15,201	12,109	18,662
Other:											
Other crustaceans	3,896	1,259	306	—	—	—	—	—	—	—	—
TOTAL CRUSTACEANS	22,964	15,279	16,354	9,423	15,756	25,074	15,303	21,935	20,223	16,434	23,927
MOLLUSKS:											
Abalone	959	553	373	318	450	414	544	449	1,089	391	369
Clams:											
Short-necked	6,007	6,752	4,966	4,580	3,235	3,743	3,840	1,939	10,905	2,273	3,637
Hard	1,798	3,184	2,462	2,305	3,284	1,487	3,332	228	1,634	1,252	1,229
Cockles	4,519	4,842	3,898	4,704	2,314	2,282	3,099	681	7,221	1,520	2,034
Cuttlefish	3,976	5,400	3,077	5,012	3,909	2,753	—	2,224	86,628	116,876	56,938
Mussels:											
Sea	9,543	6,266	3,891	1,944	3,168	3,282	2,670	2,608	3,277	2,743	2,917
Fun	2,231	1,984	363	371	140	935	724	1,587	462	—	83
Other	1,418	1,878	476	113	—	—	—	—	—	—	—

(Continued)

Table 7.—Republic of Korea's coastal fishery catch, by species, 1962-72—continued.

Species	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
	Metric tons										
Octopus:											
Octopus	1.133	907	503	1.121	1,715	1,940	2,654	953	1,238	1,599	2,351
Other	2.801	1.878	2,410	1,615	2,335	1,330	815	1,106	1,447	1,002	1,055
Oysters	8.394	7.851	5,618	6,351	3,486	2,402	3,744	1,247	10,240	3,529	4,160
Squid	52.749	37.625	72.142	59,898	84,664	38,945	75,473	68,398	—	—	—
Topshell whelk	5.046	3.903	2,587	2,620	2,921	2,760	4,892	2,718	1,439	1,938	1,146
Other mollusks	14.260	11.995	11.069	7.631	10.786	7,629	6,884	7,171	8,763	3,751	3,069
TOTAL MOLLUSKS	114.834	95.018	113.835	98.583	122.407	69.902	108,671	91,309	134,343	136,874	78,988
AQUATIC ANIMALS:											
Sea cucumber	1,877	1.682	1,331	1.080	1.264	1,201	1,392	716	1,049	391	332
Sea urchin	1.904	2,041	3.364	981	592	739	448	201	301	251	95
Other	6.777	8.187	11,075	9.160	10.152	12.330	5,045	5.969	1,953	645	471
TOTAL AQUATIC ANIMALS	10.558	11.910	15.770	11.221	12.008	14.270	6.885	6,886	3,303	1,287	898
SEAWEEDS:											
Agar-agar	2.651	3.143	3.154	4,948	3.137	4,249	3,803	2,868	2,739	2,581	3,888
Duckweed	2.362	4.579	2,204	1,865	2.275	2,119	1,656	1,292	689	713	1,715
Dulse	28.123	29,721	38,420	19,789	50.442	31.240	30,075	31,939	17,734	18,365	26,334
Fusiforme	9.961	10.607	8.622	6.867	66.503	7.283	5,614	5,956	4,066	5,342	5,473
Irish moss	1.189	1.357	2.365	3.845	2.686	2,877	2,492	2,545	1,602	1,584	2,675
Kelp	1.037	1.468	780	204	31	205	279	104	56	7	39
Laver	3.155	1.213	1.171	1.141	581	200	242	1,078	3,897	5.443	1,700
Other	26.444	16.276	15.627	20.527	11.171	13.233	6.183	2,580	12,197	3,856	5,137
TOTAL SEAWEED	74.922	68.364	72.343	59.186	76.826	61.406	50.344	48.362	42,980	37,891	46,961
TOTAL COASTAL FISHING	956.276	764.179	724.365	691.348	687.004	610.707	582.893	553.070	519.459	441.638	448.117

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea, September 1973.
Note: Total catch figures do not necessarily agree with statistics for individual species because of the rounding of figures for some species.

metric tons, and it remained in the 30,000-to-40,000-metric ton range until 1971 when production suddenly increased to 69,082 metric tons. The catch continued to increase and reached 110,309 metric tons in 1972, making hairtails Korea's most abundant coastal species. Part of this increase in recent years is due to the slow modernization of the coastal fishing fleet, which is now able to fish farther out into the East China Sea. Hairtails accounted for 12 percent of the entire ROK coastal catch in 1972.

Anchovy: This species accounted for 104,174 metric tons—11 percent of the ROK coastal fisheries catch. This amount is well above the average yearly catch, because, with the sole exception of 1969 when the anchovy catch increased to 115,056 metric tons, the catch of this species has averaged around 55,000 metric tons. Recent discoveries of new fishing grounds and excellent weather in 1972 apparently contributed to the increased haul of this species.

Mackerel: Korea's coastal mackerel catch was 90,416 metric tons in 1972, and this included 2,753 metric tons of jack (horse) mackerel, 8,694 metric tons of Spanish mackerel, and 78,969 metric tons of "other" mackerels, representing, in total, 8 percent of the entire coastal catch. During the past decade the catch of "other" mackerels has soared from 4,058 metric tons in 1962 to its present record, while the catch of jack mackerel has slowly decreased; in 1962 the catch of jack mackerel was 18,419 metric tons.

Squid: Squid landings were greatest in 1968 when ROK coastal fishermen caught 84,664 metric tons. In 1971 the catch was poor, about 37,625 metric tons, but production in 1972 increased to 52,749 metric tons. Korean fishermen generally use jigging machines to catch squid at night. The catch is normally dried and eaten with beer, a combination as popular in Korea as pretzels and beer in the United States. The coastal catch is augmented by the ROK high-seas squid catch in West African waters, and considerable amounts are dried or frozen for export throughout southeastern Asia.

Corvenia: In 1972 the catch of corvenias was 45,376 metric tons. This total included 25,352 metric tons of yellow corvenia, which was slightly above the 1971 catch, but which is also well below the catch for the period 1966-70 when catches of 30,000 to 50,000 metric tons were common. Other corvenia are also caught in about the same amounts. Much of this catch is processed and frozen; the remainder is generally sold locally as fresh or chilled fish.

Alaska pollock: South Korean coastal fishermen catch Alaska pollock off the Korean peninsula, and 1972 was a particularly successful year; 40,492 metric tons were caught, whereas in the past three years the catch never exceeded 13,000 metric tons and before that the catch generally fluctuated between 20,000 and 30,000 metric tons. One reason for the increased catch in 1971-72 was the lifting of size restrictions on Alaska pollock by the South Korean Government in October 1970.

The coastal catch of Alaska pollock, when combined with the high-seas catch of 107,961 metric tons, depressed the local market price for Alaska pollock from \$0.10/lb in May 1972 to a low of \$0.04/lb in August 1972. Partially as a result of this dramatic drop in price, and because of strong protests by coastal fishermen and fish merchants whose earnings were affected, some of the ROK stern trawlers fishing for pollock in the Bering Sea switched their fishing efforts to the squid fisheries off West Africa. In addition, efforts were begun to develop a filleting industry to export Alaska pollock to the United States and Japan.

Saury: The catch of saury in 1972 was 38,544 metric tons, the highest it has been since 1966 when landings reached 39,404 metric tons. The in-

creased ROK catch of saury is the result of improved stock conditions. The Koreans usually process this saury for use as tuna bait, but other types of seafoods are also manufactured.

Dulse: The harvest of dulse by Korea's coastal fishermen has been slowly decreasing ever since production peaked at 50,442 metric tons in 1968. The 1972 harvest of 28,123 metric tons, which is slightly below the 1971 harvest, reflects this continued decrease in production. ROK officials have said that this drop in production is due to slackening demand and lower prices throughout Southeast Asia.

SHALLOW-SEA AQUACULTURE HARVEST

The ROK shallow-sea—or tideland—aquaculture fishery has yielded positive returns in the past decade: production increased over 800 percent from 18,709 metric tons in 1962 to 160,378 metric tons in 1972. This fishery now provides 12 percent of the total ROK catch. Production generally increased by an average of 15,000 tons per year, except for the period 1964-65 and 1969 when the harvest declined. Table 8 provides a statistical breakdown of Korea's shallow-sea aquaculture fishery for 1962-72.

The shallow-sea aquaculture fishery is devoted primarily to the harvest of mollusks and the collection of seaweeds. In 1972 mollusk production was 106,349 metric tons or 66 percent of the tideland harvest, while seaweed collections (mainly dulse and laver) were 53,908 metric tons or 34 percent of the harvest.

The principal species harvested is the Japanese oyster, *Crassostrea gigas*. In 1972 oyster production was 64,314 metric tons, which accounts for nearly 60 percent of the entire tideland harvest of cultivated mollusks. There was also a harvest of 8,394 metric tons of oysters by coastal fishermen.

Koreans have been culturing oysters since 1891, but this fishery was not of great importance to ROK planners until 1966. About 85 percent of Korea's oyster cultivation is by stone culture; culture with stick, rack, raft, and longline accounts for the rest. Beginning in 1966 ROK officials began to promote both raft and longline culture as a means of improving production.

Most of Korea's oyster culture takes place along the rugged southern coast where the warm waters of the Tsushima Current produce ideal conditions for the raising of the oysters. The area under cultivation grew from about 1,200 hectares in 1962 to about 6,500 hectares in 1972, and ROK officials hope to add another 30,000 hectares by 1976.

A significant event in 1972 for Korea's oyster fishermen was the US-ROK Shellfish Sanitation Agreement which was signed on 24 November 1972. Briefly stated, this Agreement allows Korea, under certain conditions, to export fresh and frozen oysters, clams, and mussels to the United States. The Agreement requires that uniform sanitation principles be applied to the production and handling of all fresh or frozen oysters, clams, and mussels intended for export to the United States. These sanitation standards must be the same as those adopted by the U.S. Public Health Service in the national shellfish sanitation program.

Because of a parasite problem in Korea's fresh oysters (not related to human health) the export of fresh ROK oysters into the United States is presently being prohibited, pending resolution of the problem through joint research. Frozen oyster exports, however, are being permitted.

ROK officials now believe that their nation can soon become a major world supplier of canned and frozen oysters. These officials optimistically estimate that Korea will be able to harvest 1,040,000 metric tons of unshucked oysters by 1976 and this should yield 250,000 metric tons of

Table 8.—Republic of Korea's shallow-sea aquaculture harvest, by species, 1962-72.

Species	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
						Metric tons					
FISH:											
Yellowtail	—	20	—	—	—	—	—	—	—	—	—
Other	—	—	22	—	—	—	—	—	—	—	—
Total	—	20	22	—	—	—	—	—	—	—	—
CRUSTACEANS:											
Shrimp	86	20	10	34	17	30	—	—	—	—	—
Other	36	10	—	—	182	—	5	—	—	—	—
Total	122	30	10	34	199	30	5	—	—	—	—
MOLLUSKS:											
Abalone	14	19	9	—	—	—	—	—	558	—	1,464
Clams:											
Hard	7,392	8,521	5,602	2,199	4,580	3,584	1,339	1,227	1,202	1,112	314
Short-necked	8,988	8,316	5,747	8,536	9,549	11,312	11,425	7,240	7,816	5,288	2,801
Cockles	10,767	18,087	19,295	19,935	17,893	10,940	7,690	7,246	8,270	5,006	212
Mother of pearl shell	—	—	—	179	—	—	—	—	—	—	—
Octopus	2	1	—	—	—	—	—	—	—	—	—
Oysters	64,314	45,663	36,981	26,814	34,683	41,959	48,218	44,747	32,419	53,337	7,636
Sea mussels	14,070	16,778	6,888	6,645	2,611	2,019	2,052	274	963	358	203
Other	802	970	346	522	755	866	926	325	2,923	552	25
Total	106,349	98,354	74,868	64,829	70,071	70,680	71,650	61,059	54,151	65,653	12,655
SEAWEEDS:											
Agar-agar	866	996	1,149	1,113	1,810	67	1,364	1,257	1,662	1,103	896
Dulse	29,028	11,103	6,625	3,355	4,344	306	3,692	1,257	5,023	1,624	369
Laver	23,042	34,801	35,782	16,204	36,443	26,025	8,478	9,838	11,081	16,783	3,439
Other	972	1,918	756	782	164	23	5,871	264	968	122	1,350
Total	53,908	48,818	44,312	21,454	42,761	26,421	19,405	12,616	18,734	19,632	6,054
TOTAL SHALLOW-SEA	160,378	147,221	119,211	86,316	113,031	97,131	91,060	73,675	72,885	85,285	18,709

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea, September 1973.
Note: Total catch figures do not necessarily agree with statistics for individual species because of rounding of the figures for some species.

Table 9.—Republic of Korea's inland fisheries catch and aquaculture harvest, by species, 1962-72.

Species	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
					Metric tons						
INLAND FISHERIES:	. . .										
Fish:											
Anchovy (*Colia* spp.)	48	—	—	—	—	—	—	—	—	—	—
Carp:											
Common	224	91	70	46	269	69	11	—	—	36	53
Other	241	115	62	—	—	—	—	—	—	8	4
Eel	134	84	62	398	270	292	280	308	1,819	507	614
Loach	71	52	2	—	—	—	—	—	—	—	—
Mandarin fish	8	2	—	—	—	—	—	—	—	—	—
Mudfish	—	—	—	—	—	—	—	—	90	288	76
Salmon	—	1	1	—	5	—	1	—	2	8	51
Snakehead	26	17	3	—	—	—	—	—	124	9	2
Sweetfish (ayu)	10	1	—	—	—	—	—	—	—	—	—
Trout	62	22	—	—	—	—	—	—	—	—	—
Whitefish	—	—	—	—	—	—	—	—	—	—	—
Other	217	77	50	451	542	493	45	6	—	67	—
Total	1,041	464	254	895	1,086	854	337	314	2,035	923	895
Crustaceans:											
Shrimp	20	—	—	—	—	—	—	—	—	—	—
Other	—	14	—	—	—	—	—	—	—	—	—
Total	20	14	—	—	—	—	—	—	—	—	—
Mollusks:											
Shellfish	42	143	125								
Other	—	77	2		—	—	—	—	—	—	—
Total	42	220	127		—	—	—	—	—	—	—
Total fisheries	1,103	696	381	895	1,086	854	337	314	2,035	923	895
INLAND AQUACULTURE:											
Fish:											
Carp:											
Common	25	6	3	93	13	25	22	30	39	39	30
Grass	2	1	—	—	—	5	1	—	—	—	—
Eel	6	158	9	21	6	—	—	—	—	—	—
Goldfish	2	2	—	1	3	—	1	—	—	—	—
Trout	15	7	3	—	—	—	—	—	—	—	—
Other	6	1	1	6	—	3	1	—	—	—	1
Total	55	174	17	120	22	33	25	30	39	39	31
TOTAL INLAND FISHERIES	1,158	871	398	1,015	1,108	887	362	344	2,074	962	926

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea.
Note: Total catch figures do not necessarily agree with statistics for individual species because of rounding of data for some species.

canned and frozen (and possibly some fresh) oyster products earning about $32 million.

Another development was the founding of the Korea Oyster Export Company Ltd. on July 13, 1972. This firm was established to act as a monopoly agent, along with the Korea General Foods Company Ltd. and the Jedong Industrial Company, for Korea's oystermen. By coordinating their sales, these three firms hope to achieve a higher price for their products on the world market.

In addition to oysters the Koreans are also attempting to develop other resources in their tideland areas on the western coasts of Korea. Since 1966 they have been trying to raise hard clams for export. Cockle culture is also expected to increase as soon as problems of seed production are solved.

INLAND FISHERIES CATCH

The Korean inland freshwater fisheries involve both fishing and fish farming. Fishermen caught 1,103 metric tons of fish—mostly carp, eel, loach, and trout—in 1972. Fish farmers produced 55 metric tons of fish—mainly carp, trout, and eel. Thus, the total inland harvest was 1,158 metric tons—slightly less than 1 percent of the entire ROK catch. Fluctuations in the catch of inland species during the past decade have made it difficult to establish a distinct growth pattern for this fishery (Table 9).

The small quantity of eels (140 metric tons) caught or cultured during 1972 is a little misleading, because these eels (mainly elvers or baby eels) were exported to Japan at extremely high prices; in 1972, the ROK shipped 13,372 kg (29,482 lb) of live elvers to Japan at $129.97/kg ($58.95/lb) for a total return of $1,737,964!

Table 10.—Republic of Korea's fishing fleet, number and tonnage, 1954-72.

	Powered		Unpowered		Total	
Year	Number	GRT	Number	GRT	Number	GRT
1972	14,741	366,844	52,938	84,923	67,679	451,767
1971	14,675	307,256	53,612	85,393	68,269	392,649
1970	14,085	268,182	54,270	90,184	68,355	358,365
1969	12,852	251,065	53,263	91,215	66,115	342,280
1968	11,444	206,321	50,558	86,641	62,002	292,962
1967	10,989	179,117	46,266	82,961	57,255	262,079
1966	8,884	160,487	44,410	85,474	53,294	245,962
1965	7,572	119,515	43,480	83,648	51,052	203,164
1964	6,463	86,514	42,253	80,908	48,716	167,423
1963	6,107	80,335	41,110	79,706	47,217	160,042
1962	6,085	80,105	39,419	81,604	45,504	161,709
1961	5,015	65,457	37,285	79,412	42,300	144,869
1960	4,349	57,979	30,089	49,038	34,438	107,017
1959	3,978	52,216	24,913	37,204	28,891	89,420
1958	5,891	62,015	32,241	48,390	38,132	110,405
1957	4,598	52,241	33,154	53,105	37,752	105,346
1956	4,623	52,937	35,011	64,155	39,634	117,092
1955	4,141	52,348	35,379	73,233	39,520	125,581
1954	3,745	38,732	38,983	78,530	42,728	117,262

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea.

Japanese businessmen began cooperating with Koreans in 1970 in the culture of the Asian eel (*Anguilla japonica*). The Korea Eel Culture and Processing Company was one of the first joint eel culture ventures to be established. Four joint eel culture ventures were established in 1971 and by the end of that year 23 firms (including 5 joint ventures) were culturing eels in 183,612 m^2 of ponds. In 1972 the Japanese firm Ataka and Company and a Korean partner built a 1-million m^2 pond near the Naktong River and announced that they would raise over 300 metric tons of cultured eels per year beginning in 1973. Other Japanese firms have also begun to look to Korea as a source of cultured eels, and this business is expected to boom in coming years.

The Koreans have had some luck in culturing trout. In 1972, Korea had six firms in the trout business with 17,600 m^2 of water devoted to trout culture.

The Koreans have also tried, rather unsuccessfully to date, to develop a salmon culture program. There is a possibility that changes will be made in 1974 to improve conditions in the salmon culture industry, but a number of years will be required before it will be significant.

FLEET

In 1972 the ROK fishing fleet had 67,679 vessels totaling 451,769 GRT. This total is 590 vessels fewer than 1971, but represents a tonnage increase of 59,120 GRT, which means that the ROK fishing fleet has fewer, but larger, vessels. This development is still relatively new, because the ROK fleet increased in both number and tonnage through 1970. Table 10 provides data on the number and tonnage of the ROK fishing fleet for the period 1954-72.

Most of the ROK fishing fleet is composed of some 52,938 unpowered vessels (674 vessels fewer than in 1971) amounting to 84,923 GRT (470 GRT less than 1971). Almost all of these unpowered vessels (98 percent) are wooden of less than 1.6 GRT; together they account for 78 percent of the entire ROK fishing fleet. These craft generally work the coastal, shallow-sea, and inland fisheries of Korea and are slowly being replaced by more advanced vessels.

In 1972 the ROK had 14,741 powered vessels (84 vessels above 1971) which registered 366,844 GRT (59,588 GRT above 1971). These powered craft now average 26 GRT (versus 21 GRT in 1971) in tonnage and account for 22 percent of the entire fleet. This powered fleet includes 1,093 steel-hulled vessels. These include: 13 vessels under 20 GRT; 187 in the 20- to 50-GRT range, 349 vessels in the 50- to 100-GRT class, 212 vessels in the 100- to 200-GRT

Table 11.—Republic of Korea's steel, powered fleet, by fishery and by tonnage, 1972.

Fishery	Gross registered tons: 1-10	10-20	20-50	50-100	100-200	Over 200	Total vessels
	Number of vessels						
MARINE FISHERIES:							
HIGH-SEAS:							
Otter trawlers	—	—	—	11	6	71	88
Tuna longliners	—	—	—	—	120	240	360
Other	—	—	—	—	—	7	7
Total	—	—	—	11	126	318	455
WHALING:							
Whalers	—	—	—	8	—	—	8
Total	—	—	—	8	—	—	8
COASTAL:							
Gillnetters:							
Saury	—	—	1	—	—	—	1
Yellow corvenia	—	—	1	—	—	—	1
Total	—	—	2	—	—	—	2
Lift-net:							
Large	—	—	42	23	—	—	65
Total	—	—	42	23	—	—	65
Longline:							
Shark	—	—	9	—	—	—	9
Total	—	—	9	—	—	—	9
Purse seine:							
Powered	—	—	67	87	1	2	157
Total	—	—	67	87	1	2	157
Seiners:							
Anchovy drag net	—	7	27	4	—	—	38
Total	—	7	27	4	—	—	38
Trawlers:							
Large (One boat)	—	—	1	62	8	—	71
Large (Two boat)	—	—	6	108	47	—	161
Medium (One boat)	—	—	5	—	7	—	12
Shrimp	—	—	—	—	2	—	2
Total	—	—	12	170	64	—	246
FRESHWATER FISHERIES:							
Fishing	1	—	—	—	—	—	1
Total	1	—	—	—	—	—	1
OTHER VESSELS:							
Fish carriers	—	1	2	20	1	1	25
Patrol boats	—	4	21	9	12	4	50
Research/training	—	—	5	17	8	7	37
Total	—	5	28	46	21	12	112
TOTAL VESSELS	1	12	187	349	212	332	1,093

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea.

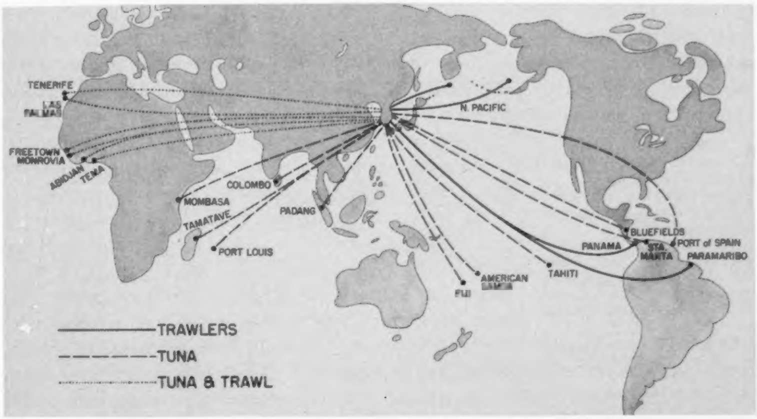


Figure 4.—Republic of Korea's high-seas tuna and trawl fleet bases and fishing grounds, 1973.

range, 332 vessels in the 200 GRT and higher tonnage range (Table 11).

Unfortunately, complete information on the ROK high-seas fleet for 1972 is not yet fully available. Information for 1971 and (curiously) for 1973 is available. Data for 1971 are referred to in the text and accompanying tables whereas data for 1973 are summarized below.

In 1973 there were reportedly 552 vessels (455 vessels in 1972) totaling 195,204 GRT (159,290 GRT in 1972) in the ROK high-seas fleet. These vessels operated from 21 foreign bases, were manned by 15,433 fishermen, and produced 382,800 metric tons (224,135 metric tons in 1972) of fish in 1973. There were 173 vessels deployed in the Atlantic Ocean, 112 vessels in the Indian Ocean, and 267 vessels in the Pacific. Figure 4 shows the location of the ROK high-seas fleet in 1973, while Table 12 provides statistics for 1971.

The ROK Government announced in early 1974 that this high-seas fleet would be increased by 150 new vessels for a total of 702 during the year. ROK officials have also projected a figure of 19,600 fishermen with a production goal of 630,000 metric tons for the high-seas fleet during 1974.

Many Korean vessels use the word "Ho" at the end of their names, e.g., *Cheog Yang Ho*. The word "Ho" in Korean means "vessel," and it is used much like the Japanese word "Maru" in identifying a vessel. Also, when numbering their vessels the Koreans avoid the number "four" because it rhymes in Korean with the word "death." This sometimes causes con-

Table 12.—Republic of Korea's high-seas fleet, areas of fishing, and overseas bases, 1971.

Oceans and bases	Fishery				
	Tuna	Trawl	Shrimp	Other[1]	Total
Atlantic Ocean:					
Abidjan	46	—	—	—	46
Capetown	—	—	—	—	—
Freetown	7	—	—	—	7
Las Palmas	16	15	—	2	33
Monrovia	—	—	—	—	—
Montevideo	—	—	—	—	—
Paramaribo	—	—	5	—	5
Port-of-Spain	13	—	—	—	13
St. Martin	12	—	—	—	12
Tema	4	—	—	—	4
Tenerife	19	—	—	—	19
Total	117	15	5	2	139
Indian Ocean:					
Mombasa	10	—	—	—	10
Penang	4	—	—	—	4
Port Louis	15	—	—	—	15
Tamatave	23	—	—	—	23
Total	52	—	—	—	52
Pacific Ocean:					
Bering Sea	—	34	—	—	34
Fiji	20	—	—	1	21
Off Japan	—	3	—	—	3
Samoa	102	—	—	—	102
Total	122	37[2]	—	1	160
Grand total	291	52[2]	5	3	351

[1]Unidentified. Believed to operate from these bases, but exact location has not been specified.
[2]In addition there were 20 additional vessels reportedly "attached" to the high-seas trawl fleet operating in the Pacific Ocean. These vessels were included in some of the trawl fleet statistics to show a total of 77 vessels, but were not included in other statistics. These 20 vessels reportedly were not fish carriers, but may include research vessels, patrol vessels, fuel or supply ships. As such they may not be a part of the high-seas fishing fleet (which numbers 351 vessels), but could be related to this fleet.

Table 13.—Republic of Korea's high-seas tuna longline fleet operations, by number of vessels reported based, or transhipping, in overseas bases or ports, 1958-72.

Overseas base or Transhipping port	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958
							Number of vessels								
ATLANTIC OCEAN:															
Abidjan, Ivory Coast	44	46	25	6	3	—	—	—	—	—	—	—	—	—	—
Capetown, South Africa		—		—	—	—	—	—	—	—	—	—	—	—	—
Fortaleza, Brazil		—		3	—	—	—	—	—	—	—	—	—	—	—
Freetown, Sierra Leone		7		21	21	[1]	2	—	—	—	—	—	—	—	—
Las Palmas, Canary Islands		16		10	10	[1]	[1]	—	—	—	—	—	—	—	—
Monrovia, Liberia		—		—	—		15[2]	—	—	—	—	—	—	—	—
Port-of-Spain, Trinidad		13		—	—		1	[1]	1	—	—	—	—	—	—
Saint Martin, Neth. Antilles		12		4	4		—	—	—	—	—	—	—	—	—
Sao Vicente, Cape Verde		—		5	5	3	—	—	—	—	—	—	—	—	—
Tema, Ghana		4		11	10	[1]	12[2]	—	—	—	—	—	—	—	—
Tenerife, Canary Islands		19		—	—		—	—	—	—	—	—	—	—	—
Total		117		60	53		29		1	—	—	—	—	—	—
INDIAN OCEAN:															
Durban, South Africa		—		20	15	[1]	[1]		—	—	—	—	—	—	—
Mombasa, Kenya		10		—	—	—	—	—	—	—	—	—	—	—	—
Penang, Malaysia		4		6	10	[1]	[1]	—	—	—	—	—	—	—	—
Port Louis, Mauritius		15		—	3		3		—	—	—	—	—	—	—
Tamatave, Malagasy Republic		23		12	6		[1]		—	—	—	—	—	—	—
Total		52		38	34		3		—	—	—	—	—	—	—
PACIFIC OCEAN:															
Espiritu Santo, New Hebrides		—		7	7		15		2	—	—	—	—	—	—
Pago Pago, American Samoa		102		67	72	67	48	30	17	10	5	1	3	3	2
Suva, Fiji Islands		20		18	20		—	—	—	—	—	—	—	—	—
Total		122		92	99		63		19	10	5	1	3	3	2
GRAND TOTAL		291		190	186		95		20	10	5	1	3	3	2
Total high-seas tuna fleet	360	291	246	191	179	170	130	65	20	10	5	1	3	3	2

[1]Unspecified number of vessels reported operating out of, or transhipping through, an overseas base or port.
[2]Vessels known to have operated from more than one base or port during the same year (i.e., 15 vessels fished out of Liberia in early 1966, then 12 of these vessels were based at Tema for the remainder of the year).
Note: Information for 1972 and 1970 is not yet available. In other instances a blank space denotes the possibility that vessels may, or may not, have operated from these bases.

fusion because the number of vessels shown is always more than the actual number of vessels in the fleet.

The following sections examine the historical development of both the high-seas tuna and trawl fleets. Information on both fleets has been rather sketchy to date, and it is expected that this treatment will provide a full understanding of the history and future direction of both fleets.

High-seas Tuna Fleet

Korea's high-seas tuna fishery dates back to 1957 when the ROK National Fisheries Development Office dispatched the Jedong Industrial Company's 229-short ton longliner, the *Chinam-Ho No. 1* to the Indian Ocean for exploratory fishing. The cruise lasted 100 days and produced only an estimated 50 metric tons of tuna. Poor financing and the poor condition of the vessel contributed to the lack of success of the mission.

After the vessel's return, the Jedong Company negotiated a contract to supply tuna to the cannery of the Van Camp Sea Food Company at Pago Pago in American Samoa. Accordingly, the *Chinam-Ho* left with a sister ship to begin fishing for tuna in the Pacific Ocean. During 1959 and 1960 three longliners fished out of American Samoa, but, in 1961, only one fished there.

In 1962 the Korean authorities and industry leaders decided that tuna fishing was worth developing. First, five tuna vessels were ordered and built in Japan with financial assistance from U.S. tuna industry backers. Second, ROK fishery officials set in motion a multimillion-dollar project to build a large fleet of tuna longliners in Italy and France. This project, however, was delayed for several years because of the tremendous financial outlays required. The agreement was finally signed on 13 March 1964 and totaled $35 million (a considerable drop from the $120 million originally proposed). The program called for the construction of 61 tuna longliners in France and 15 longliners in Italy, which—along with some additional trawlers (see the next section)—totaled 91 vessels.

While this project was still being negotiated, a series of loan agreements were reached in 1963 with private U.S. financial companies and with a West German group for the construction of additional tuna vessels. Five vessels were added to the existing tuna fleet in 1963 for a total of 10 vessels. The ROK tuna fleet doubled in size in 1964 to 20 vessels.

On 30 April 1965, the first of the Italian-French Consortium-built vessels, the *Nam Hae 202, 205,* and *206,* were turned over to ROK captains at the France-Gironde shipyards at Bordeaux. The 144-GRT longliners immediately left for Pago Pago. By the end of 1965 about 30 to 35 of these Italian- and French-built vessels were fishing, many of them from ports in West Africa. In 1966, all but a few had been delivered and the South Koreans re-entered the Indian Ocean tuna fishery with three longliners which were based in Port Louis.

In 1967, just 10 years after the *Chinam-Ho No. 1* had entered the Indian Ocean, the South Koreans had 170 tuna longliners in operation in all three oceans; their catch in 1967 was 38,460 metric tons valued at $12 million. Since then the ROK high-seas tuna fleet has increased rapidly with each passing year: 179 longliners in 1968, 191 vessels in 1969, 246 in 1970, 291 in 1971, and 360 in 1972. Table 13 provides details on the deployment of this fleet throughout the world for the period 1958-72.

Unfortunately, detailed information regarding the ROK tuna fleet, its areas of operation, and its catch for 1972 is not available. However, since information for 1971 is available it has been summarized below.

In 1971 the ROK fleet had 291 tuna longliners. All were under 10 years old, and all were built of steel. These longliners were owned by 36 different companies including 23 firms which had only tuna vessels and 13 companies which had both tuna vessels and trawlers. In 1971 some 7,475 fishermen were employed in the tuna fisheries. About 28 percent of the tuna fleet were between 101 and 200 GRT, 40 percent were between 201 and 300 GRT, and 28 percent were between 301 and 650 GRT.

These 291 vessels operated out of 13 different overseas bases in 1971. The most important of these bases, with 102 longliners, was American Samoa. In 1971 the Koreans built a "Korea House" on the island which is used to provide crews with personal articles, mail, supplies, and recreational facilities. Abidjan in the Ivory Coast was the next most important base for the ROK high-seas tuna fleet in 1971.

These 291 vessels were deployed as follows: 122 longliners (42 percent of the fleet) fished in the Pacific Ocean where they caught 36 percent of the total tuna catch. In the Atlantic Ocean were 117 vessels (40 percent of the fleet), which landed 44 percent of the total tuna catch. Finally, 52 vessels (18 percent of the fleet) fished in the Indian Ocean and caught 20 percent of the total catch.

As indicated previously, the ROK high-seas tuna fleet increased in size to 360 vessels in 1972 and probably included over 400 longliners in 1973. This number will probably continue to grow, because ROK planners have already begun to discuss expansion plans for the period 1974-81.

High-seas Trawl Fleet

The French-Italian Consortium loan that helped spark the development of the ROK high-seas tuna fleet also enabled the Koreans to develop a modern high-seas trawl fleet. The loan included provisions for the construction of:

Ten 130 GRT side-trawlers
Two 1,330 GRT stern trawlers
Two 220 GRT stern trawlers
One 300 GRT research vessel[1]

The first high-seas trawler to be launched was the 1,330 GRT stern trawler *Kang Wha 601* (Fig. 5), which was christened in June 1965 at the Dubigeon-Normandie shipyards in France. The vessel was outfitted in December 1965 and in early 1966 began fishing out of Las Palmas in the Canary Islands.

This vessel was later joined by her sister ship, the *Kang Wha 602,* two 220 GRT stern trawlers called the *Keo Mun 501* and *502,* plus four 130

[1]The plans to construct the research vessel were later cancelled, and a 530 GRT stern trawler, the *Huk San No. 701,* was built in its place.

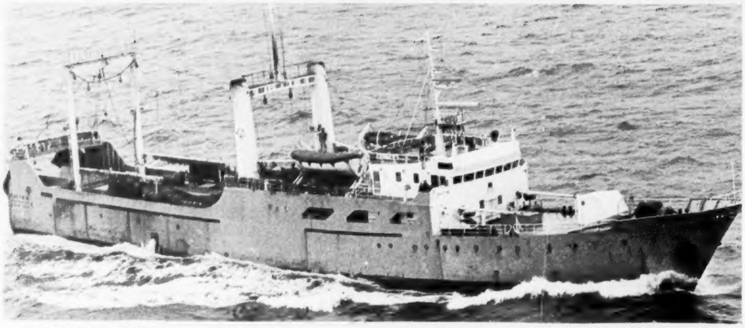


Figure 5.—The Republic of Korea's first high-seas stern trawler, the 1,330 GRT *Kang Wha 601*, photographed off Alaska in 1969.

Figure 6.—The 3,000 GRT stern trawler *Cheog Yang Ho* steaming off the eastern Aleutian Islands.

GRT coastal side-trawlers (10 were eventually built) called *Baek Nyong*. These eight French-built vessels reportedly caught 1,379 metric tons of fish during 1966.

The year 1966 also marked the beginning of Korea's entry into the North Pacific trawl fisheries. On 16 July 1966 the Pusan Fisheries College training vessel *Paekkyong-Ho* (White Whale) left Pusan Harbor bound for the waters off Alaska. Between August and September 1966 the vessel fished in both the Bering Sea and the Gulf of Alaska before returning home in October. The results of this experimental voyage were to spark the development of Korea's commercial high-seas trawl fishery in the North Pacific.

On 18 August 1967 the Samyang Fisheries Company launched its First ROK Fishing Expedition to the North Pacific. A 957 GRT refrigerated transport, the *Sam Su No. 301*, was the mothership for eight 99 GRT Japanese-built otter trawlers called *Sam Su Nos. 2, 3, 5, 6, 7, 8, 9*, and *10*. The expedition was a disaster. First, two of the company's new otter trawlers sank in heavy seas near Adak and 29 crewmen lost their lives. Second, the president of the Samyang Company died unexpectly while investigating the earlier tragedy. Third, bad weather reduced fishing to a total of 5 days out of the 50-day expedition and the few fish that were caught were eaten by the crew before the fleet reached home port. Finally, the fleet was dogged by mechanical difficulties and lack of adequate navigational equipment. The crews, largely untrained conscripts, were unable to deal with the harsh conditions of the North Pacific fisheries.

Despite the difficulties in the North Pacific the Koreans had made a commitment to build a modern, high-seas fleet and progress in this direction was being made. In the Atlantic Ocean two additional 130 GRT coastal sidetrawlers (*Baek Nyong*) were added to the existing fleet of eight vessels that fished in 1966.

In a related development the former dry cargo vessel *Bataan* was completely refitted in the Norwegian shipyards of the Akers Group of Oslo for the Shin Hung Refrigeration Co. This 7,073 GRT vessel, renamed *Shin Hung*, was rebuilt to process 100 metric tons of raw fish per day. When work was completed the vessel had a cold-storage facility that could hold 2,900 metric tons of fish at $-25°C$ in a 6,800 m^3 hold. Additionally, the vessel had a two-line canning plant able to process 10 tons/hour with a storage area for 2,500 metric tons of canned fish plus a 25 metric ton/day fishmeal production capacity with a 400 metric ton fishmeal and a 200 metric ton fish oil storage hold. The vessel was to appear in the North Pacific in 1969.

In 1968 the Koreans withdrew seven vessels from their 10-vessel Atlantic fleet and sent three of these vessels to the North Pacific. The newly launched *Huk San 701* was, instead, added to the Atlantic fleet, thus leaving four vessels off West Africa. This fleet reportedly landed 809 metric tons of fish. The remaining vessels were presumably sent back to Korea.

In 1968 the ROK Pacific fleet included the Samyang Company fleet with its mothership, six trawlers, and the refrigerated transport *Sam Su No. 201*. The Samyang Company again encountered many difficulties: bad weather, mechanical breakdowns, snarled gear, lack of drinking water, U.S. immigration problems, and untrained crews. The three vessels which had previously fished in the Atlantic fleet—the *Keo Mun 501* and *502* and the *Kang Wha 601*—however, had no difficulties in their fishing for Alaska pollock in these northern Pacific waters.

In 1969 an 800 GRT stern trawler (unidentified) was added to the fleet of four vessels operating in the Atlantic Ocean fisheries off western Africa. Three of these vessels were based in Las Palmas, the other two in Monrovia, Liberia.

In August 1969, five 72-ft steel-hulled shrimp trawlers were built by the Mexican shipyard Astilleros Unidos del Pacifico for the Jedong Fishery Company. These shrimp trawlers, called *Jinam Ho*, cost $96,000 each, and they were quickly sent to the

shrimp grounds off Paramaribo in Surinam.

On the Pacific side the Koreans added 17 new vessels to their fleet in 1969. The Samyang Company again operated the largest fleet in 1969. The company employed seven new 133 GRT Japanese-built otter trawlers called *Kook Yang*, under the command of the 7,073 GRT mothership *Shin Hung* (which had been rebuilt in Norway in 1967). The *Shin Hung* was actually owned by the Shin Hung Refrigeration Co., but that firm, instead, operated a mothership called the *Kook Yang No. 51*. To confuse matters even more, the Shin Hung Company employed the identical vessel used by the Samyang Company, e.g., five 133 GRT Japanese-built vessels called *Kook Yang*. These vessels, however, were rigged for gill netting. Finally, in addition to these vessels, the ROK operated four independent stern trawlers.

Most of the ROK North Pacific fishing in 1969 proceeded smoothly, except for the salmon gill netters. The U.S. Coast Guard immediately discovered this effort, and the fleet was kept under continual surveillance while strong protests were made by the Alaska fishing industry and government, the U.S. Congress, and the State Department. The ROK gill net fishery abruptly ended on 8 July 1969.

The year 1970 was a turning point for the ROK high-seas trawl fisheries in the North Pacific. First, the number of ROK vessels in this fishery reached a peak: two motherships, 11 trawlers, 11 gill netters, two support vessels, and two indepdendent trawlers. In subsequent years the size of the ROK fleet was reduced. This was apparently because of the severe financial strains suffered by many of the companies which had fished in the North Pacific in previous years. It was apparent that the smaller vessels could not profitably work in this fishery, and, as a consequence, ROK industry and government leaders decided to concentrate on larger vessels. Secondly, the Koreans realized that any salmon fishing would immediately encounter strong resistance from the United States (a short-lived attempt was made to fish salmon in 1970, but the fishery was again promptly discovered and United States objections finally forced the end of this abortive fishery).[2] As a consequence the ROK realized that its future in the North Pacific fisheries lay in the development of the Alaska pollock resources.

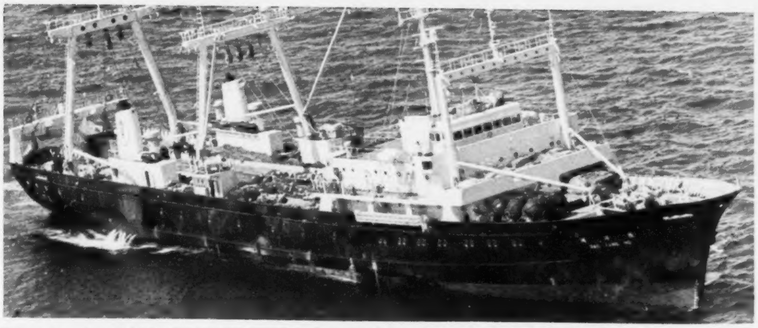


Figure 7.—The 3,000 GRT *Gae Yang Ho* photographed off Alaska in July 1973. Her sister ship is the *Cheog Yang Ho* (Fig. 6).

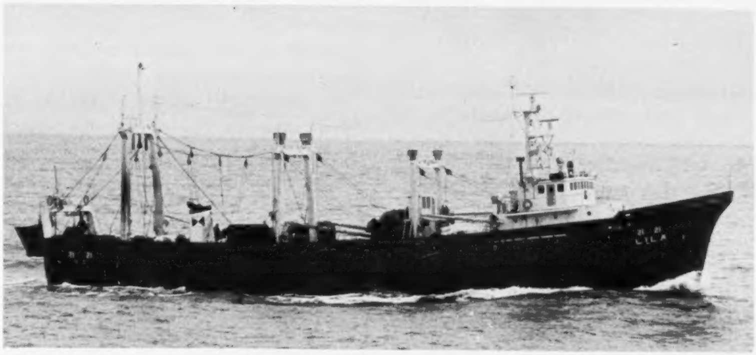


Figure 8.—The *Lila*, a 912 GRT stern trawler, was built in a Republic of Korea shipyard in November 1971.

The year 1970 was also a turning point in the high-seas trawl fisheries in the Atlantic Ocean. The three stern trawlers that had previously fished in the Pacific Ocean (1968-69) were sent back to the Atlantic Ocean along with four of the 130 GRT side trawlers that had been pulled out in 1968. The Atlantic Ocean trawl fisheries have since remained an important element in ROK high-seas trawl fisheries.

In 1971, the ROK North Pacific fleet was reduced to 17 vessels: one mothership, 10 otter trawlers, three support vessels, and three independent stern trawlers. All these vessels fished primarily for Alaska pollock. The most important development of the year for this fishery was the entry of the newly constructed 3,000 GRT stern trawlers *Cheog Yang Ho* (Fig. 6) and *Gae Yang Ho* (Fig. 7). These two Japanese-built stern trawlers were the newest and largest in the entire ROK fleet. The two vessels were supported by a 1,652 GRT refrigerated transport, the *Chil Bo San No. 5*, which was the newest and largest vessel of this type built in Korean shipyards.

In 1971 the ROK high-seas trawl fleet in the Atlantic was increased from 17 vessels to 20 vessels and reportedly caught 6,941 metric tons of fish. The size of this fleet remained unchanged in 1972, but the catch increased to 9,327 metric tons.

In 1972 the North Pacific trawl fleet declined in number; only eight independent stern trawlers, without any support vessels, fished in the North Pacific. Seven of these trawlers fished off Alaska while one was reported fishing off Kamchatka. These eight vessels included: *Cheog Yang Ho*

[2] In late 1972, the United States and the Republic of Korea entered into a 5-year fisheries agreement whereby the ROK agreed not to fish for salmon or Pacific halibut east of 175° West longitude in the eastern Bering Sea and northeastern Pacific Ocean.

(3,000 GRT), *Gae Yang Ho* (3,000 GRT), *Clover* (1,400 GRT), *Lila* (912 GRT), *Kum Yung No. 105* (400 GRT), *Ode Yang No. 107* (300 GRT), *Kaiyogo*, and *Iris* (700 GRT estimated), which fished off Kamchatka.

All these vessels except the *Kum Yung No. 105*, which was a used Japanese vessel, were relatively new. The *Lila*[3] (Fig. 8) had been launched in Pusan (recently renamed Busan) in November 1971. The *Clover* was launched in Japan during the same month, and it is logical that the *Iris* was also a recent addition. There are no additional facts about the *Ode Yang No. 107* and the *Kaiyogo*, but there is reason to believe that these vessels were also recently constructed. These eight vessels reportedly landed 117,138 metric tons of fish during the season which lasted from March through September 1972.

Additionally, several other vessels were added to the ROK high-seas fleet during 1972, but these new vessels were not reported as having fished in the North Pacific during that year (many were sighted off Alaska in 1973). These other new vessels included: *Hwa Rang* (404 GRT) launched on 17 December 1971, *Kum Kang San* (739 GRT) launched in May 1972, and the *Han Il Ho* (1,179 GRT) launched in June 1972. These three stern trawlers were all built in the Niigata Shipyards in Japan for the Korea Wonyang Company. Another new addition was the 1,000 GRT stern trawler *Shinam Ho No. 305*, which was launched on 12 May 1972, at the Daisen Shipyard of Busan. Other additions included the *Dong Bang No. 71* (1,459 GRT) which was built in Japan in December 1972, the *Mae Kum Kang* (1,800 GRT), the *Han Jin Ho* (2,100 GRT), and the *Goyo Ho No. 70* (1,600 GRT). Complete details regarding these four vessels are not yet available. Finally, there was a report of the construction of a 3,500 GRT vessel identified as *Hoyo*, which is probably an error.

In summary the Koreans were intensely busy modernizing their fleet during 1972. It is also apparent that the South Koreans have deliberately embarked upon a program designed to make their nation a major high-seas fishing nation.

[3]The vessel probably should be called *Lilac* since the other two vessels in her class—the *Iris* and *Clover*—both have names of flowers.

FISHERMEN

There were 1,061,562 people employed in the ROK fisheries in 1972, which is 103,670 below 1970. Employment in the Korean fisheries began declining in 1968, and the drop during the period 1970-72 is nearly a 9-percent drop. This is a rather sharp decrease, but because the ROK fisheries are still overmanned, this decrease in the population will not have a negative impact.

A surprising factor in the ROK fishery population is that the labor is almost equally divided between men (52 percent) and women (48 percent). Korean women harvest seaweeds, mollusks, and other aquatic marine life in addition to playing an important role in fish processing.

Another rather surprising fact is that the sea continues to attract young people. In nearby Japan, by contrast, the fishing industry appears to be losing in its efforts to lure new recruits while maintaining the overall fishing population and the Japanese badly need new people in their fishing industry. Fortunately, the ROK fishing industry can afford to trim its ranks.

There were 188,443 persons classified as full-time workers deriving all of their income from fisheries in 1972 as against 873,119 part-time workers. This means that the hard core of the fishing industry is relatively small, making it easy to manage and train.

Education for ROK fishermen began to play an increasingly important role in the early 1960s when ROK planners began to develop programs to build a high-seas fishery. Through trial and error it had become obvious that Korean fishermen would need new skills to master the intricacies of high-seas fishing. In 1964 the ROK Government placed $1.6 million—along with a $1.3 million United Nations Development Program (UNDP) loan—into the establishment of a Deep-Sea Fisheries Training Center. The program began on 1 July 1965. Initially, training for masters and engineers lasted for 12 months and included five months of classroom training, six months of training aboard ship, and one month of final schooling and examinations. The program was later extended to 18 months. Rigorous training and iron discipline were demanded in every phase of the work. Training took place aboard one of the three deep-sea training vessels purchased by the Center: the *Chindalle No. 1* and *2* and the *Kaenali*. By late 1972 a total of 709 officers and engineers had graduated and more than one-third of the entire ROK high-seas fleet was manned by graduates of this program.

This training program was so successful that a Coastal Fishing Training Center was established on 8 July 1969. The objectives of this program were the same as with the Deep-Sea Center with the exception that these graduates (216 men in 1971) were to fill the ranks of Korea's coastal fisheries. In order to train these coastal fishermen the Government of Korea purchased the *F/T Dong Baeg No. 1* and *2* (50 and 60 GRT, respectively). These two vessels were used to train crewmen in the art of fishing with longlines, gill nets, and Danish seines. Two additional vessels were also purchased with UNDP funds: the *Dong Baeg No. 3* and *5* (both 120 GRT) are now used for purse seining and stern trawling. Each vessel carries a crew of seven and each has room for 14 to 15 trainees. The catch is sold locally and the funds received in payment are deposited in a special account which is used to offset operating costs.

In early 1972 the Coastal Fishing Training Center, backed by a $500,000 UNDP grant, ordered two new skipjack pole-and-line vessels from the Usuki shipyards in Japan. On 31 July 1972, the Center took delivery of the 200 GRT *Gwanag San No. 1* and *2*. On 8 January 1973, a reconditioned Japanese skipjack vessel purchased by the UNDP, the 253 GRT *Gwanag San No. 3*, was delivered to the Center.

With UNDP assistance a one-year training program for a group of 10 deck officer trainees and five engineering students was begun. Special emphasis was placed on live bait fishing.

Table 14.—Republic of Korea's production of seafood products, by major commodity groups, 1950-72.

Year	Dried	Salted dried	Cooked	Salted preserved	Pickled	Canned	Frozen	Dried seaweed	Agar-agar	Ground fish	Seasoned fish	Fishmeal & oil	Others	Total
							Metric tons							
1972	16,794	346	8,955	2,153	8,650	7,883	90,236	15,937	118	1,608	1,463	2,606	5,097	161,846
1971	7,247	373	4,269	1,362	5,951	13,588	75,377	10,595	227	543	1,183	1,150	1,553	123,417
1970	13,855	756	2,951	1,562	4,581	5,352	62,312	11,297	461	443	937	527	576	105,610
1969	9,651	2,512	7,766	1,576	4,036	5,067	24,291	13,165	471	56	735	482	6	69,814
1968	19,176	2,906	4,475	3,774	11,660	3,688	18,487	11,490	—	—	—	628	983	77,267
1967	8,967	2,474	10,217	4,546	15,669	4,956	22,136	13,154	—	—	—	922	1,917	84,758
1966	14,187	1,806	9,944	5,080	7,852	6,336	25,353	9,730	—	—	—	1,152	973	82,413
1965	14,012	1,823	3,718	1,711	8,905	7,438	38,751	11,623	—	—	—	2,007	1,962	91,950
1964	17,619	919	2,240	2,803	8,308	4,741	18,935	8,415	—	—	—	1,309	50	65,339
1963	23,576	919	4,735	5,041	8,539	2,207	3,590	10,123	—	—	—	1,179	179	60,088
1962	18,872	1,380	7,594	5,692	11,112	1,236	163	10,591	—	—	—	845	47	57,532
1961	20,182	725	9,580	9,914	13,116	6,713	53	8,206	3	—	—	793	140	69,425
1960	11,984	626	13,542	7,260	8,157	8,616	—	5,775	—	—	—	659	11	56,630
1959	12,710	1,819	9,943	10,429	18,039	10,317	3	5,807	—	—	—	704	—	69,771
1958	12,512	2,068	9,063	12,489	14,619	1,275	—	5,385	—	—	—	93	—	57,504
1957	12,323	2,827	8,866	14,475	19,002	792	28	7,730	—	—	—	237	10	66,290
1956	8,434	2,490	8,412	13,591	16,622	268	—	6,409	—	—	—	217	59	56,502
1955	8,014	1,049	4,535	13,628	5,579	1,051	—	5,527	—	—	—	94	300	39,777
1954	7,217	1,424	4,744	16,843	6,542	—	—	10,236	—	—	—	376	10	47,395
1953	7,726	2,524	11,752	22,558	9,877	223	—	3,196	—	—	—	198	—	58,054
1952	—	—	—	—	—	—	—	—	—	—	—	—	—	45,539
1951	—	—	—	—	—	—	—	—	—	—	—	—	—	45,140
1950	—	—	—	—	—	—	—	—	—	—	—	—	—	38,694

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea.

catching, and holding methods. Additional training was provided for a group of 15 to 20 seamen in skipjack fishing methods.

Before the year had ended it was reported that two Panamanian-flag skipjack vessels, manned by South Koreans, had begun fishing out of Tema, Ghana. The two vessels were both 190 GRT baitboats exported from Japan to Panama. Their operations were reportedly funded by the Japanese trading firm Marubeni Iida. In December 1972 it was reported in the Japanese press that the Korea Wonyang Company had signed a contract with Mitsubishi Shoji for construction of two 424 GRT skipjack vessels. These vessels, named *Paektusan No. 1* and *2*, were built at the Miho Shipyard and were delivered in the summer of 1973 for skipjack fishing out of Tema, Ghana. Finally, as a follow up to these developments, the Central Federation of Fisheries Cooperatives, backed by a $13.3 million Asian Development Bank loan, announced in late 1973 that it would accept bids for the construction of eight 400 GRT skipjack pole-and-line vessels. Thus, the training programs of the UNDP and the Coastal Fishing Training Center resulted in a rapid development of a new fishery for the Korean nation.

In addition to these training programs, Korea also has two fishery colleges, four junior colleges (or technical schools), and nine fishery high schools. Finally, under various foreign training agreements, some 16 Korean fishermen trained abroad during 1971.

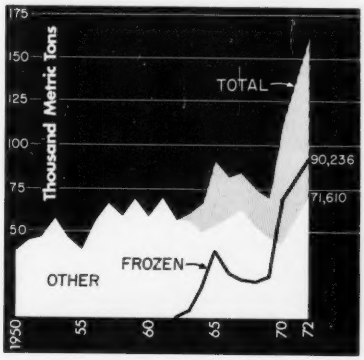


Figure 9.—Republic of Korea's seafood production, 1950-72.

SEAFOOD PROCESSING

In 1972 some 739 processing facilities in Korea utilized 405,787 metric tons of raw fishery products and produced 161,846 metric tons of processed seafood. This was 38,429 metric tons more than the 123,417 metric tons produced in 1971. The South Korean seafood industry has grown rapidly in recent years, mainly because of the rapid expansion of the frozen seafood industry. Table 14 and Figures 9 and 10 provide statistical and graphic evidence of the growth of this industry since 1953.

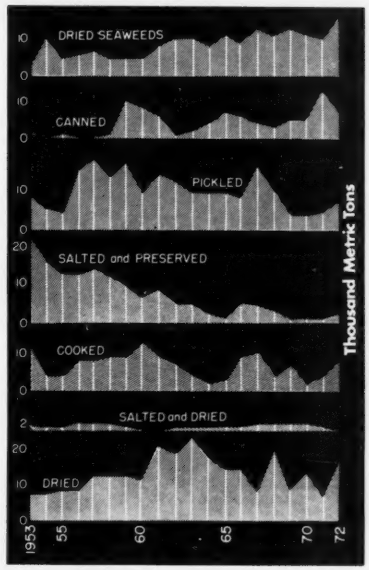


Figure 10.—Republic of Korea's production of processed fishery products by major commodity groups, 1953-72.

A capsule summary of the various seafood products manufactured in Korea is provided below in order of importance:

Frozen: The most impressive developments in the ROK seafood processing sector have been made by the frozen seafood industry. In the late 1950s this industry began producing a small amount of frozen shrimp. In 1962, production began in earnest and the industry expanded its operation to include mackerel and yellow

corvenia for human consumption and frozen saury for use as bait on tuna vessels. By 1965, the industry's output had soared to 38,751 metric tons; however, this rapid expansion caused some production and marketing problems and production decreased between 1966 and 1968. In 1969, partly as a result of the ROK Government's efforts to expand production and introduce new products, and partly as a result of better world markets, the industry again began expanding production. By 1972, frozen seafoods accounted for 56 percent (90,236 metric tons) of all processed seafoods manufactured in Korea. Most of this production was frozen yellowtail, squid, octopus, short-necked clams, topshells, scallops, cockles, and oysters, plus shrimp, mackerel, yellow corvenia, and saury. In addition to these products, Korea's 118 frozen seafood plants have also branched out and now sell ice to fishermen and process both poultry and livestock.

The most significant development for Korea's frozen seafood industry in 1972 was the dedication of a 6,000-ton-per-year Alaska pollock filleting plant in Ulsan. The plant was built by the Han Sung Industrial Company, which has already begun exporting to the United States and Australia. Towards the end of the year the Japanese Hokushi Fisheries Association announced that it would build a 100 percent Japanese-owned Alaska pollock filleting factory in the free zone at Masan. Frozen fillet blocks produced by this company are to be exported to the United States and Japan.

This development is important because the local Korean market was glutted with Alaska pollock during the summer of 1972 and prices dropped sharply. With increased domestic landings and with the tremendous high-seas production of Alaska pollock, the move to build processing plants able to produce an exportable product will relieve the market disruptions suffered during 1972. Alaska pollock fillets should become a major item manufactured by the South Koreans during the coming years.

Dried: This industry was Korea's top producer in 1964, but it has since dropped to second place because of the rapid expansion of the frozen seafood industry. In 1972, Korea produced 16,794 metric tons of dried seafood, which accounted for 10 percent of the total processed fish production of that country. The 46 major firms in this industry dry squid, Alaska pollock, anchovy, and yellow corvenia. During 1971 the industry encountered some difficulty obtaining raw materials because of the increased production of frozen squid and the utilization of more yellow corvenia in the seasoned and flavored products industry.

Dried seaweed: In 1972 Korea produced 15,937 metric tons of dried seaweed, which also accounts for about 10 percent of Korea's seafood production. Dulse, laver, fusiforme, and Irish moss are the main species of seaweed dried in Korea. An estimated 52 firms in Korea produce "slightly burned" seaweed, and 33 others manufacture other types of dried seaweed.

Cooked: In 1972, Koreans prepared 8,955 metric tons of cooked seafood (6 percent of the country's output). A clear background regarding the types of products made by this industry has not been provided in Korean literature, but at least one product, "mackerel pike," is boiled and canned.

Pickled: Anchovy and shrimp are the two species of importance in Korea's seafood pickling industry, and 8,650 metric tons of this product were produced in 1972.

Canned: The most important decrease in production in 1972 was suffered by the canning industries of Korea: production dropped from 13,588 metric tons in 1971 to 7,883 metric tons in 1972. There have been no explanations for this drop, except that 1971 was an exceptionally pro-

Table 15.—Republic of Korea's exports of fishery products and equipment, by quantity and by value, 1962-72.

Commodity	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962
Quantity:						*Metric tons*					
Agar-agar	493	342	329	425	415	804	610	734	569	524	506
Canned seafoods	2,628	951	377	2,053	1,846	665	4,647	2,891	3,132	355	545
Dried laver	325	1,257	1,452	969	1,243	672	528	571	434	247	226
Dried seaweeds	5,108	4,085	2,939	3,100	1,855	3,055	3,975	4,177	3,999	2,663	3,314
Frozen seafoods	18,200	11,528	8,394	4,581	3,679	4,518	4,914	3,472	2,179	2,099	1,140
Live or fresh seafoods	37,890	24,458	14,805	11,884	13,877	13,307	15,724	17,479	14,790	11,564	10,992
Preserved seafoods	1,413	1,247	479	854	866	1,724	2,008	1,212	641	986	—
Squid	4,808	4,377	6,346	3,616	1,780	4,678	7,606	7,413	10,827	5,691	6,361
Tuna	107,334	90,725	89,621	80,800	50,074	36,200	26,852	6,438	1,338	2,313	—
Other seafoods	2,754	1,429	470	413	804	802	758	1,371	872	224	1,800
Fishing nets	6,347	5,995	4,953	3,617	—	—	—	—	—	—	—
Total quantity	187,300	146,394	130,165	112,312	76,439	66,425	67,622	45,758	38,781	26,666	24,884
Value:						*US$1,000*					
Agar-agar	1,731	1,171	1,227	1,780	1,851	5,800	2,753	2,176	1,849	1,641	1,420
Canned seafoods	5,006	1,885	375	2,184	2,221	519	1,655	1,406	826	372	272
Dried laver	3,223	4,749	11,592	21,721	17,054	14,371	6,838	3,781	5,391	1,343	1,267
Dried seaweeds	3,234	2,678	1,525	998	588	929	1,002	819	654	328	352
Frozen seafoods	12,510	8,001	5,994	4,556	4,653	6,084	3,872	2,368	2,255	1,763	1,381
Live or fresh seafoods	27,366	18,217	11,353	6,764	7,232	6,721	6,967	7,389	6,059	4,190	4,327
Preserved seafoods	4,554	2,629	1,566	1,224	1,217	1,730	1,368	882	519	843	—
Squid	11,435	9,361	10,335	4,156	1,970	4,630	6,290	5,452	5,010	2,078	2,371
Tuna	68,032	55,103	37,663	24,072	15,559	11,969	7,971	2,404	320	625	—
Other seafoods	5,382	2,074	1,109	492	732	635	477	561	402	404	951
Fishing nets	10,091	9,113	7,313	5,969	4,246	4,111	2,843	1,254	381	103	—
Total value	152,564	114,981	90,052	73,916	57,323	57,499	42,036	28,492	23,666	13,690	12,341

SOURCE: Office of Fisheries, *Yearbook of Fisheries Statistics, 1973*, Republic of Korea.

ductive year for three reasons: (1) the renewed ROK military purchases of canned seafood, (2) a drop in the price of certain raw fish, and (3) a surge in exports of canned oysters. The only other time that production of canned goods exceeded 10,000 metric tons was in 1959 when large sales were made to Korean military forces. Another possible reason for the decrease in 1972 (although not reported) is that Korean canners also pack mushrooms and peaches, and it is possible that increased production of these fruits and vegetables may have been at the expense of fishery items.

Canned oysters, saury, and mackerel are the principal species packed by this industry. Others include squid, crab, topshell, shrimp, abalone, and sea mussels. In the past two years the Koreans have also been attempting to develop a market for canned herring and squid packed with vegetables, in addition to other types of canned fishmeat, sausages, and crab roes. These are being packed under the Government's plan to diversify the products available for export.

Salted and preserved: Koreans prepared 2,153 metric tons of salted and preserved products in 1972. This accounts for 1 percent of the seafood output during the year.

Fishmeal and oil: The waste prod-

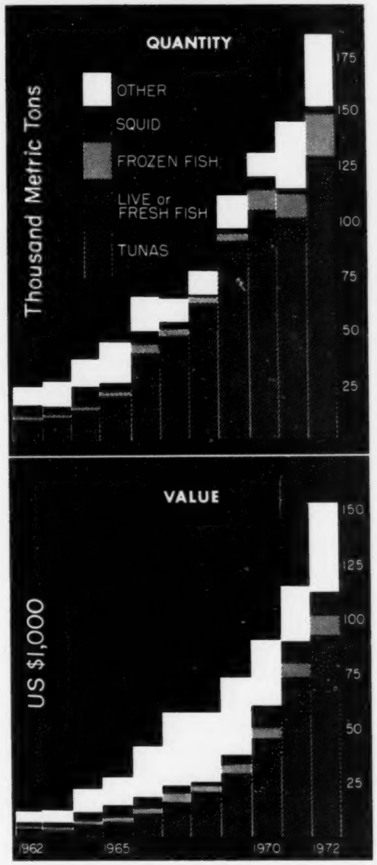


Figure 11.—Republic of Korea's exports of fishery products, by quantity and value, 1962-72.

Table 16.—Republic of Korea's fishery exports, by value and country, 1962 and 1966-72.

Country	1972	1971	1970	1969	1968	1967	1966	1962
	US$1,000							
Japan[1]	73,101	48,919	38,657	36,190	33,752	35,546	25,442	7,333
United States	36,387	29,332	34,592	20,293	12,445	13,112	9,205	1,646
Nigeria	2,675	3,565	1,767	1,781	1,152	1,449	1,325	—
Kenya	2,046	1,878	547	355	285	208	104	—
Hong Kong	1,865	837	1,020	497	299	567	754	1,826
Italy	1,446	1,854	344	240	385	321	215	6
Sierra Leone	1,377	1,480	1,816	965	—	318	—	—
Malaysia	1,363	—	—	—	—	—	—	—
Ghana	1,334	—	—	—	—	—	—	—
Netherlands	1,258	1,655	1,334	810	191	113	30	—
Singapore	953	650	946	592	500	778	735	333
Taiwan	934	2,459	421	2,270	1,018	825	735	155
Indonesia	925	—	—	—	—	—	—	—
Canada	502	127	78	212	110	227	305	36
Thailand	269	219	502	553	338	717	593	354
West Germany	195	—	—	—	—	—	—	—
United Kingdom	177	—	—	—	—	—	—	—
Sweden	14	—	—	—	—	—	—	—
Other	25,743	22,006	8,028	9,158	6,848	3,318	2,548	636
Total	152,564	114,981	90,952	73,916	57,323	57,499	42,036	12,325

[1]Includes Okinawa.
Note: Malaysia, Ghana, Indonesia, West Germany, the United Kingdom, and Sweden may have been listed under "other" countries in previous years.

Table 17.—Republic of Korea's fishery exports, by country, commodity, and quantity, 1972.

Country	Exports by commodity										Nets	Total
	Tunas	Live/fresh	Frozen	Dried seaweed	Squid	Canned	Preserved	Agar	Laver	Other		
	Metric tons											
Japan[1]	a/a	37,889	15,980	4,636	4,135	48	1,384	270	262	2,187	360	67,151
United States	n/a	—	579	145	34	1,900	24	6	21	76	504	3,289
Nigeria	—	—	—	—	—	—	—	—	—	—	1,646	1,646
Hong Kong	—	—	4	68	287	55	—	62	—	301	29	806
Indonesia	n/a	—	—	—	—	—	—	—	—	—	396	396
Taiwan	—	1	—	—	308	9	5	—	28	10	20	381
Ghana	n/a	—	—	—	—	—	—	—	—	—	309	309
Canada	—	—	—	—	*	162	—	—	1	1	129	293
Singapore	n/a	—	—	—	29	7	—	60	—	87	68	251
Netherlands	n/a	—	94	4	—	9	—	1	1	13	30	152
Sierra Leone	n/a	—	—	—	—	—	—	—	—	—	122	122
Kenya	n/a	—	—	—	—	—	—	—	—	102	102	102
West Germany	—	—	30	2	*	44	—	1	—	6	15	98
United Kingdom	n/a	—	—	—	—	—	—	—	—	—	89	89
Thailand	—	—	—	—	15	—	—	45	1	1	15	77
Italy	n/a	—	67	—	—	—	—	—	—	3	—	70
Malaysia	—	—	—	—	—	—	—	3	—	1	10	13
Sweden	—	—	6	—	—	—	—	—	—	1	4	10
Others	n/a	—	1,440	253	—	394	—	45	11	69	2,499	4,711
Total	107,334	37,890	18,200	5,108	4,808	2,628	1,413	493	325	2,754	6,347	187,300

[1]Includes Okinawa.
n/a - Quantities of tuna shipped have not been reported and do not appear in total export figures.
* - Less than 1 metric ton.

ucts from Korea's canneries, seasoning-flavoring industries, and from the fish-drying industries are used in fishmeal production. Processing of fishmeal is undertaken by four firms. Some 90 firms produce fish liver oil (mainly from shark livers) and fish oil.

Seasoned: This industry involves the adding of soy sauce and sugar to certain fishery products, particularly squid. In 1972, this industry purchased unusually large quantities of yellow corvenia which normally would have been dried. In 1972 some 35 firms engaged in the manufacture of 1,463 metric tons of seasoned or flavored seafood products.

Ground: In 1972 Korea produced 1,608 metric tons of ground or minced fish. Generally only the cheapest species of fish are ground for local consumption. Some 70 small-scale companies undertake this type of production.

Salted and dried: In 1972, production of salted and dried seafood was 346 metric tons.

Agar-agar: Production of this seaweed began in 1969 when 471 metric tons of processed agar-agar were manufactured. Production has since fallen steadily, and in 1972 only 118 metric tons were produced.

Other: The Koreans produced 5,097 metric tons of "other" seafood products during 1972. Production of whale products (by three firms) is believed to be a part of this production. No other information is available on these other forms of processed seafood products.

FISHERY EXPORTS

Koreans exported a record-breaking 187,300 metric tons of fishery products worth $152 million to more than 80 different countries during 1972. In terms of quantity, this achievement represents a sevenfold increase over the 24,884 metric tons exported in 1962, while the value of these shipments is 12 times greater than the $12 million worth of goods sold by Korea in 1962.

The rapid rate of growth during the past few years can be directly attributed to the ROK Government's efforts to expand and promote exports. This effort was begun in 1969 because of the decrease in ROK exports to Japan and the United States in 1968. Korean officials were quick to realize the dangers of relying too heavily upon a few products sent to a few countries. Therefore, these officials called for the diversification of production techniques, the development of new products, and the establishment of new markets. Despite these efforts, however, the Japanese and United States markets still dominate Korea's exports: in 1972 the Japanese purchased 47 percent of Korea's total exports while the United States imported 24 percent of that nation's fishery products for a 71 percent total of Korea's fishery exports.

Table 15 and Figure 11 provide additional statistical and graphic information on the development of Korea's fishery exports by quantity and value for the period 1962-72. A brief description of Korea's 1972 exports follows.

Tuna: In 1972 Korea exported 107,334 metric tons of tuna worth $68.0 million: U.S. importers or canneries purchased $31.0 million worth of this tuna, or slightly less than half of this amount. Japan was Korea's second largest customer for tuna, accounting for $9.1 million. Exports were also made to Kenya ($1.8 million), Malaysia ($1.3 million), Italy ($1.3 million), Sierra Leone ($1.1 million), and the Netherlands ($1.0 million). Smaller shipments were made to Ghana, Indonesia, Singapore, and Great Britain. An additional $19.6 million worth of ROK tuna was exported to "other" countries. Unfortunately, ROK statistics do not provide the quantities of tuna exported to these countries. Most of these sales were made directly from ROK tuna longliners based in many of these nations or through transshipments made abroad.

Live or fresh: Korea exported 37,890 metric tons of live or fresh fishery products worth $27.3 million in 1972, and 99 percent of these exports went directly to Japan; only 1 metric ton worth $75,000 went to Taiwan. With the Japanese market within easy reach of Korea it is possible to fly shipments to the Japanese fish markets within hours of the fishes' being caught or harvested. The shipment of live eels to Japan was an especially profitable business for South Korean eel culturists during the year.

Frozen: Exports of frozen fish (excluding tuna) were 18,200 metric tons worth $12.5 million in 1972. Japan took the lion's share of this trade with 15,980 metric tons worth $10.8 million, and the United States followed with 579 metric tons worth $411,000. Exports of frozen seafoods were also made to the Netherlands, Italy, West Germany, Sweden, and Hong Kong, in addition to other countries.

Squid: Korea's total squid exports were 4,808 metric tons worth $11.4 million, and almost all of this (4,129 metric tons worth $9.9 million) went to Japan. Squid, which is considered a delicacy throughout Southeast Asia, also went to Taiwan, Hong Kong, Singapore, and Thailand. Shipments were also made to the United States, Canada, and West Germany.

Canned: Korea exported 2,628 metric tons of canned seafoods worth $5 million during 1972. The United States purchased more than half these exports, or 1,900 metric tons worth $3.5 million. Canada came second with 162 metric tons, followed by Hong Kong, Japan, West Germany, the Netherlands, Taiwan, Singapore, and other countries.

Seaweeds: In 1972 Korea exported 5,108 metric tons of dried seaweed worth $3.2 million, 325 metric tons of dried laver worth $3.2 million, and 493 metric tons of agar-agar worth $1.7 million (agar-agar exports exceed the total production figure for this product in 1972—no explanations have been provided by ROK authorities for this difference). Most of Korea's seaweed exports went to Japan, but small shipments were sent to many other nations throughout the world.

Pickled, salted, or preserved: 1,413 metric tons of variously preserved seafoods worth $4.5 million were exported in 1972 and, again, Japan imported the lion's share—1,384 metric tons worth $4.5 million.

Fishing nets and ropes: The Koreans have developed a profitable fish net and rope industry and have found customers for these products all over the world. In 1972 they exported

6,347 metric tons of netting and rope worth $10 million.

Tables 16 and 17 provide additional statistics on Korea's exports of fishery products to different countries, for different commodities, during the period 1962-72.

SUMMARY

It is always difficult to project the future direction of a nation's fisheries. However, in the case of the Republic of Korea, it is quite possible that the Koreans may meet or exceed their targets during the coming years. These goals were outlined by the Director General of the ROK Office of Fisheries, Kim Dong Soo, in October 1972:

> "The nation's fisheries production is projected at 2 million metric tons and annual exports of marine products at $350 million by 1976. As a result, the nation is anticipated to rank the fifth in the world in terms of fisheries production and the first in terms of annual exports of marine products."[4]

Whether or not these projections are reached, it is certain that the Republic of Korea will become better able to serve the needs of the nation in fishing and it is also certain that Korean fishermen will be recognized throughout the world as ambitious and skilled fishermen.

[4]Office of Fisheries, *Pictorial Korean Fishery*, Republic of Korea, 1972.

MFR Paper 1098. From Marine Fisheries Review, Vol. 36, No. 11, November 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.

MFR PAPER 1099

Abnormal red color can be removed from oysters by heat treatment.

Thermal Bleaching of Red Algal Pigment in Shucked Oysters

V. G. BURRELL, JR.

Formerly a member of the staff of the Virginia Institute of Marine Science, Gloucester Point, VA 23062, V. G. Burrell, Jr. is now associated with the Marine Resources Research Institute, P.O. Box 12559, Charleston, SC 29412. This paper is Contribution No. 633 from the Virginia Institute of Marine Science and Contribution No. 20 from the South Carolina Marine Resources Center.

ABSTRACT—A technique for decoloring oysters exhibiting "red liquor" due to ingesting algal pigment is described. The abnormal color was permanently removed by holding the oysters at 55°C for 25 minutes in the aeration tanks. Heat treatment did not noticeably affect the taste or keeping quality of the oyster meat and is feasible using equipment commonly found in most Chesapeake Bay shucking houses.

INTRODUCTION

"Red liquor" in shucked oysters has been a chronic problem for packers (Beaven, 1964; Burrell, 1971; Hunter, 1920; Lear, 1958; Lear and Manning, 1957; and Sieling, 1971). Plant pigments, derived from algae on which the oyster has been feeding, constitute a principal cause of this coloration (Lear, 1958). The color is often not noticeable when the oysters are shucked and packed but may develop several days after packing, when oysters are held at temperatures just above freezing, or immediately after frozen oysters have thawed. The wholesomeness and flavor of such oysters is in no way impaired, but customer rejection often causes serious financial losses to packers (Nelson, 1948).

Oysters feed on the algae causing red color only about two weeks out of each year. Such algae are usually present before oysters cease to feed in the fall and are a problem for only a week or two in shucked oysters. However, during some years the pigment apparently is retained in the intestinal tract of oysters from fall to the following spring (Lear, 1958). Thus, "red" oysters can be a problem to shucking houses for the entire season. Serious outbreaks of red liquor in oysters appear to follow an extended warm fall (Nelson, 1948).

A method of eliminating red pigmentation from shucked oysters would be advantageous to the oyster industry. For a bleaching technique to be of value to the industry, 1) the treated product must have all the attributes of fresh oysters in appearance, taste, and keeping quality, 2) cost of labor and equipment to process oysters must be minimal, and 3) yield after processing should not be greatly reduced.

The purpose of this study was to determine the feasibility of thermal bleaching, employing laboratory and field tests.

LABORATORY TESTS

Objective

Laboratory tests were undertaken to determine the length of time oysters must be held at a specific temperature to decolor red algal pigment. A temperature-time regime least affecting

the appearance, taste, and keeping qualities of oysters was sought.

Methods and Materials

Pint containers of red oysters, obtained from a local shucking house, were held at internal temperatures of 40, 45, 50, 55, and 60°C for 15, 20, and 25 minutes in water baths, for a total of 15 different regimens. Prior to heating, oyster gut contents and free liquor in the can were inspected microscopically to establish that coloration was not due to yeast or bacteria. The pH was used to determine freshness because this criterion is applied by military purchasers, and significant quantities of frozen oysters involved in the red oyster problem go to this market. Novak and Fieger (1957) found that pH was too variable to be used as a test of freshness in commercially stored oysters, but that pH did decrease slowly in stored oysters. The pH was determined by homogenizing oyster meats in a blender and testing with a Beckman Model SS 3 pH meter before and after treatment. In replicate tests, pH was averaged according to Kinney (1973).

Each treatment was applied to ten pints of oysters. One pint from each treatment regimen was frozen and thawed, as this is the surest method of demonstrating red pigment if it is still present in oysters (Table 1). A second group of 45 pints (3 from each regimen) was stored under dry refrigeration of 3-6°C; the third group of 90 (6 pints from each regimen) was held in crushed ice (Tables 2 and 3). The latter two groups were tested every 5 days for appearance, taste, smell, and pH for 15 and 30 days respectively.

Visual observations were made to determine if red color was present and if treated oysters were visibly different from oysters not receiving heat treatment. Two or more raw oysters from each container were eaten at the prescribed intervals to note taste change, if any, with storage time. Smell was also noted at each interval.

Controls of uncolored, fresh oysters (obtained in an area free from problems with red oysters) were stored under similar conditions to compare keeping qualities of treated with untreated oysters.

Table 1.—Treated oysters frozen and thawed after three days.

Temperature °C	Time in Minutes	Appearance	pH Before Treatment	pH After Thawing
40	15	red	6.4	6.4
40	20	red	6.4	6.4
40	25	red	6.4	6.4
45	15	red	6.4	6.4
45	20	red	6.4	6.4
45	25	red	6.4	6.4
50	15	red	6.4	6.4
50	20	clear	6.4	6.5
50	25	clear	6.4	6.4
55	15	clear	6.4	6.4
55	20	clear	6.4	6.4
55	25	clear	6.4	6.5
60	15	clear	6.4	6.4
60	20	clear	6.4	6.4
60	25	clear	6.4	6.5
Control	Control	clear	6.4	6.4

Table 2.—Storage of treated oysters in dry refrigeration at 3-6°C.

		5 days		10 days		15 days	
Temperature °C	Time in Minutes	pH	Appearance	pH	Appearance	pH	Appearance
40	15	6.3	red	6.2	red	5.7	red
40	20	6.4	red	6.2	red	5.6	red
40	25	6.4	red	6.1	red	5.7	red
45	15	6.5	red	6.2	red	5.6	red
45	20	6.4	clear	6.1	red	5.8	red
45	25	6.4	red	6.2	red	5.8	red
50	15	6.4	red	6.3	red	5.8	red
50	20	6.4	clear	6.2	clear	5.6	red
50	25	6.4	clear	6.2	red	5.7	red
55	15	6.3	clear	6.1	clear	5.7	clear
55	20	6.5	clear	6.3	clear	5.8	clear
55	25	6.4	clear	6.3	clear	5.7	clear
60	15	6.4	clear	6.2	clear	5.7	clear
60	20	6.3	clear	6.1	clear	5.8	clear
60	25	6.4	clear	6.2	clear	5.6	clear
Control	—	6.3	clear	6.2	clear	5.7	clear

Table 3.—Oysters held in ice in a cold room at temperatures of 0-2°C after heat treatment.

Treatment Temperature °C	Time in Minutes	5 days		10 days		15 days		20 days		25 days		30 days	
		Appearance	pH	Appearance	pH	Appearance	pH	Appearance	pH	Appearance	pH	Appearance	pH
40	15	red	6.4	red	6.4	red	6.2	red	6.2	red	6.2	red	6.1
40	20	red	6.5	red	6.4	red	6.2	red	6.1	red	6.1	red	6.1
40	25	red	6.5	red	6.4	red	6.2	red	6.1	red	6.2	red	6.1
45	15	red	6.4	red	6.4	red	6.2	red	6.2	red	6.1	red	6.0
45	20	red	6.5	red	6.5	red	6.3	red	6.2	red	6.1	red	6.0
45	25	red	6.4	red	6.4	red	6.1	red	6.1	red	6.1	red	6.1
50	15	red	6.5	red	6.4	red	6.1	red	6.2	red	6.1	red	6.1
50	20	clear	6.4	red	6.4	clear	6.2	clear	6.2	clear	6.2	clear	6.2
50	25	clear	6.4	red	6.4	red	6.3	red	6.2	red	6.2	red	6.1
55	15	clear	6.4	clear	6.4	clear	6.2	clear	6.2	clear	6.2	clear	6.2
55	20	clear	6.4	clear	6.4	clear	6.2	clear	6.2	clear	6.1	clear	6.1
55	25	clear	6.5	clear	6.4	clear	6.2	clear	6.1	clear	6.1	clear	6.1
60	15	clear	6.5	clear	6.4	clear	6.2	clear	6.1	clear	6.1	clear	6.0
60	20	clear	6.4	clear	6.4	clear	6.2	clear	6.2	clear	6.2	clear	6.1
60	25	clear	6.4	clear	6.4	clear	6.2	clear	6.2	clear	6.1	clear	6.0
Control	—	clear	6.4	clear	6.4	clear	6.2	clear	6.2	clear	6.1	clear	6.1

Results of Laboratory Tests

Oysters heated to 40°C remained noticeably red (Tables 1, 2, and 3). One pint of those heated to 45°C initially lost red color, although it returned after freezing and thawing and upon storage (Tables 1, 2, and 3). Red color was lost and did not return after freezing and thawing in oysters heated to 50°C for more than 15 minutes, but the color returned following storage (Tables 1, 2, and 3). All oysters treated at 55°C and 60°C lost red pigmentation and did not regain it after freezing and thawing or during storage of up to 30 days (Tables 1, 2, and 3).

No pH change occurred immediately after heat treatment, but during both storage in ice and dry refrigeration the pH dropped in both controls and treated oysters at the same rate (Tables 2 and 3). There was no visual evidence, such as shrinkage or curled mantle edges, to indicate that oysters had been heated, other than the loss of red color. Flavor of oysters held in ice began to deteriorate and a slight odor developed in both test oysters and controls at 25 days, but neither were spoiled at 30 days. Deterioration of flavor and development of a slight odor occurred at 15 days in oysters held at 3-6°C under dry refrigeration.

Conclusions on Laboratory Tests

Fresh canned oysters heated to 55 and 60°C for 15 minutes lost red coloration caused by algal pigments. Taste, appearance, and smell were not adversely affected by these treatments. This indicated that temperatures in this general range would be best for initial field tests. Time at temperature however might require some further experimentation since, in laboratory tests, time recorded was the period that the center of the oysters in the can were held at desired temperatures. The aeration step in processing is the logical place to treat oysters since heated water may be readily applied. Aeration or "blowing" refers to a procedure where 15 to 20 gallons of fresh shucked oysters are placed in 75- to 150-gallon stainless steel open top vessels, three-fourths filled with water. Compressed air is then piped into these vessels, agitating oysters, so that shell and grit is washed out. Aerators or blowing tanks have tap water, steam, and compressed air supplied from the bottom of the tanks.

Table 4.—Oysters held in a household refrigerator at 3-6°C after heat treatment in an aerator for 25 minutes.

Treatment Temperature °C	0 days Appearance	pH	5 days Appearance	pH	10 days Appearance	pH	15 days Appearance	pH	Without heat treatment frozen and thawed	
50	clear	6.4	red	6.3	*				83% red	17% clear
53	clear	6.5	40% red	6.3	25% red	6.2				
			60% clear	6.3	75% clear	6.2	*		90% red	10% clear
55	clear	6.4	clear	6.3	clear	6.3	clear	5.8	92% red	8% clear
Control	clear	6.4	clear	6.2	clear	6.2	clear	5.8	100% clear	

*No further tests

FIELD TESTS

Objectives

One objective was to determine if it is feasible to heat oysters for a sufficient time in aeration tanks prior to packing in cans in order to decolor algal pigments which cause red coloration. A second objective was to determine shelf life of heat-treated oysters.

Methods and Materials

Oysters used in field tests were selected from batches of oysters known to have red pigment although color might not be apparent. This was determined by inspecting the gut of torn oysters and rapid freezing and thawing of suspected oysters. These oysters came from several areas including upper Chesapeake Bay, Rappahannock River, Potomac River, and Louisiana.

Batches of these oysters, varying in quantity from 10 to 20 gallons of both standards and selects, were placed in aerators three-fourths filled with water which had been heated by steam injection to temperatures of 50, 55, and 60°C. Additional steam was introduced into the tanks until the temperatures reached 50, 53, and 55°C after the oysters had been added. The oysters were aerated for 5 minutes and then allowed to soak for 20 minutes. Temperatures were maintained at 50, 53, and 55°C throughout the aerating and soaking periods. From time to time, the oysters were stirred to maintain a uniform temperature throughout the tank. After oysters had soaked for 20 minutes, cold water was run into the tanks until they overflowed to cool the oysters and wash out grit. In some tests, conducted at 55°C, ice was added to the holding water to lower the temperature of the oysters to packing stage more rapidly. In these instances, soaking was reduced to 18 minutes prior to removal from the aerators.

After treatment, six pint cans of treated oysters from each batch and one can of control oysters were held in a household refrigerator at 3-6°C. Six additional pint cans of treated oysters, one gallon of treated oysters, and one can of control oysters were held in crushed ice in a cold room at 0-2°C. Both of these groups were examined for appearance, taste, smell, and pH at 5-day intervals for a maximum of 30 days. Taste and olfactory observations in this case were the same as in the laboratory tests except that controls and half-pint containers receiving each treatment were distributed at the 5-day intervals to laboratory colleagues for home consumption. Subjects were not told the history of the oysters nor was any stipulation made as to how the oysters were to be prepared. Reports from these people indicated that the oysters were eaten raw, steamed, fried, stewed, and scalloped. (A formal taste panel could not be established for this investigation.)

Controls consisted of oysters from an area not having the "red" problem, shucked simultaneously with "red" oysters. Additionally, six pint cans from the batch of oysters to be treated were frozen and thawed without treatment to determine the likelihood of "red" color showing up in the remaining oysters, had they not been treated. These oysters were inspected microscopically and found to be free of "pink" yeast or bacteria which might cause red color.

Results of Field Tests

Oysters known to contain red pigment in their intestinal tracts that were subjected to 50°C for 25 minutes

Table 5.—Oysters held in crushed ice in a cold room maintained at 0-2°C after heat treatment in an aerator. pH is a mean of all replicates. Replicates at 55°C included pint and gallon cans.

Treatment Temperature °C	0 days Appearance	pH	5 days Appearance	pH	10 days Appearance	pH	15 days Appearance	pH	20 days Appearance	pH	25 days Appearance	pH	30 days Appearance	pH	Without heat treatment frozen and thawed
50	clear	6.4	red	6.3	*				*						83% red 17% clear
53	clear	6.4	25% red	6.3	25% red	6.3	10% red	6.3	10% red	6.2	10% red	6.1	10% red	6.1	
			75% clear		75% clear		90% clear		90% clear	6.2	90% clear	6.1	90% clear	6.1	90% red 10% clear
55	clear	6.4	clear	6.4	clear	6.3	clear	6.3	clear	6.2	clear	6.0	clear	6.0	92% red 8% clear
Control	clear	6.4	clear	6.3	clear	6.3	clear	6.3	clear	6.3	clear	6.1	clear	6.0	100% clear

*No further tests

showed no obvious color when placed in storage (Tables 4 and 5). All of these oysters developed red color upon storage. Those raised to 53°C for 25 minutes were clear when placed in storage, but 10-66% developed red color, with larger oysters most often showing color. Oysters subjected to 55°C for 25 minutes did not develop red coloration in storage up to 30 days. Oysters from the same batch in each instance above, not having received heat treatment, showed red color when frozen and thawed in 83%, 80% and 92% of the cans, respectively. Keeping quality as measured by depression of pH of treated oysters and controls showed no difference (Tables 4 and 5).

Gallon containers kept as well as pint containers (Table 5). Appearance in all instances was the same in treated as in untreated oysters. Taste tests by the author indicated no difference with time in treated and untreated oysters. The reaction of recipients of test oysters was in every instance favorable with no greater acceptability for control oysters. Again a slight odor developed in both control and treated oysters held in a household refrigerator at 15 days, and at 25 days in those held in ice at 0-2°C. Heat treatment time reduced to 23 minutes at 55°C by adding crushed ice to the aerator for cooling purposes was sufficient to decolorize the red pigment.

CONCLUSION

Oysters may be held at 55°C for 23 to 25 minutes during the aeration process in a shucking house to decolorize red pigments derived from algal food of oysters. A temperature of 53°C during the aeration process is sufficient for small oysters (standards); however, grading by most shuckers is not strict enough to prevent some large (select) oysters from getting into nearly every batch. Therefore, the lower temperature is not reliable.

Advantages of heat treatment of oysters to decolor ingested red plant pigments are:

1) Oysters are no longer subject to customer rejection due to appearance.
2) Treated oysters have the same shelf life as untreated oysters.
3) Neither taste nor appearance (other than loss of red color) is altered.
4) The process may be carried out using existing equipment.

The main disadvantage of this process is the need for strict adherence to time and temperature. This requires close supervision throughout the treatment. Temperatures higher than those prescribed may denature the proteins in the oyster and increase the difficulty in cooling oysters to packing temperature.

Although this treatment has been effective in degrading the red pigment in oysters from many areas during the winters of 1971 and 1972, it may not work for all red algal pigments ingested by oysters and other bivalves.

ACKNOWLEDGMENTS

Special thanks are due Hogg Oyster Company, Cook Oyster Company, and Virginia Seafoods, Inc., for the use of their equipment and providing oysters for this study and to Mr. Frosty Seafoods, Inc., who provided the freezer supplies.

I am grateful to Drs. J. D. Andrews, F. D. Ott, F. O. Perkins, and Mr. D. S. Haven of the Virginia Institute of Marine Science for their helpful criticism and advice.

This study was supported by the Sea Grant Program of the National Oceanic and Atmospheric Administration of the U. S. Department of Commerce, Contract Number 1-36032 (1971).

LITERATURE CITED

Beaven, G. F. 1964. Comments on the occurrence and nature of certain types of coloration in oysters. Nat. Resour. Inst., Univ. Md., Ches. Biol. Lab. Ref. 64-5, 3 p.

Burrell, V. G. 1971. Pink coloration in oysters. Va. Inst. Mar. Sci., Mar. Resour. Inf. Bull. 3(3):6-7.

Hunter, A. C. 1920. A pink yeast causing spoilage in oysters. U.S. Dep. Agric. Bull. 819, 24 p.

Kinney, E. C. 1973. Average or mean pH. Prog. Fish-Cult. 35:93.

Lear, D. W. 1958. Further red shellfish coloration studies. Several causes for red coloration. Md. Tidewater News 14:11.

Lear, D. W., and J. H. Manning. 1957. Study of red shellfish coloration initiated. Md. Tidewater News 13(9):1-2.

Nelson, T. C. 1948. Oysters giving off reddish juice when cut prove excellent food. Trade Rep. 99, Oyster Inst. North Am., 3 p.

Novak, A., and E. A. Fieger. 1957. Research on handling and processing southern oysters. Proc. Natl. Shellfish Assoc. 47:148-150.

Sieling, F. W. 1971. Harmless coloration of oysters explained. Commer. Fish. News, Fish Wildl. Admin. Md. 4(2):1-2.

MFR Paper 1099. From Marine Fisheries Review, *Vol. 36, No. 11, November 1974. Copies of this paper, in limited numbers, are available form D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1100

Increased utilization of latent and underutilized fish stocks—these are the objectives of the . . .

New England Fisheries Development Program

WARREN F. RATHJEN

Figure 1.—Typical catch of "mixed" species taken off southern New England. Quite often 20-30 percent of trawl catch is discarded owing to the small size of the fish or the lack of a traditional market. Changes in handling and processing technology could reduce this waste to a negligible figure.

INTRODUCTION

Solutions to the basic problems confronting the New England fishing industry are being addressed, but actions to secure control over resources off the U.S. coast and correct other root problems plaguing the area will not take effect immediately. In the interim, the National Oceanic and Atmospheric Administration (NOAA), in partnership with the fishing industry, is responding to this challenge through appropriate short-term approaches to increase the availability of latent or underutilized fish stocks which will help alleviate the existing resource crises and aid industry in reversing the decline evidenced in most New England fisheries. The principal departure from traditional approaches is that the program will utilize the direct input of industry in concert with the resources of NOAA's National Marine Fisheries Service (NMFS) and Sea Grant and of other entities in accomplishing mutually agreed on objectives.

The plight of the New England fishing industry is well known. The accelerated international exploitation of fishery resources off the New England coast, however, has contributed to problems which have grown numerous and at times seemingly intractable, particularly during the last decade. Industry in New England has felt the full effect of these problems and the resource crises whose aftermath will affect this industry for some time to come. The impact of the influx of fishing fleets from 20 countries onto grounds traditionally fished by the United States may be best measured in the drastic decline in the catch of food fish by New England fishermen. The quantity of fish landed in 1970 and 1971 dropped 46 percent from the 1962 and 1963 landing figures.

Efforts (bilateral and ICNAF—International Commission for Northeast Atlantic Fisheries) to control high seas fishing in areas of interest to U.S. fishermen have been of limited success in that most stocks of principal U.S. interest continue to be depressed or declining. The Law of the Sea Conference deliberations hold some eventual promise for coastal state preference, but agreements appear several years off.

Certain segments of this industry cannot continue without improvement in resource availability. NMFS believes the most effective interim effort to offset the economic decline of the New England fishing industry lies in fuller use of fish presently harvested (incidental catch) and diversification of fishing effort to harvest stocks not now fished to potential.

Resources such as squid (two species) with an estimated potential annual harvest in excess of 100 million

Warren F. Rathjen is at the Northeast Regional Office, National Marine Fisheries Service, NOAA, 14 Elm Street, Gloucester, MA 01930.

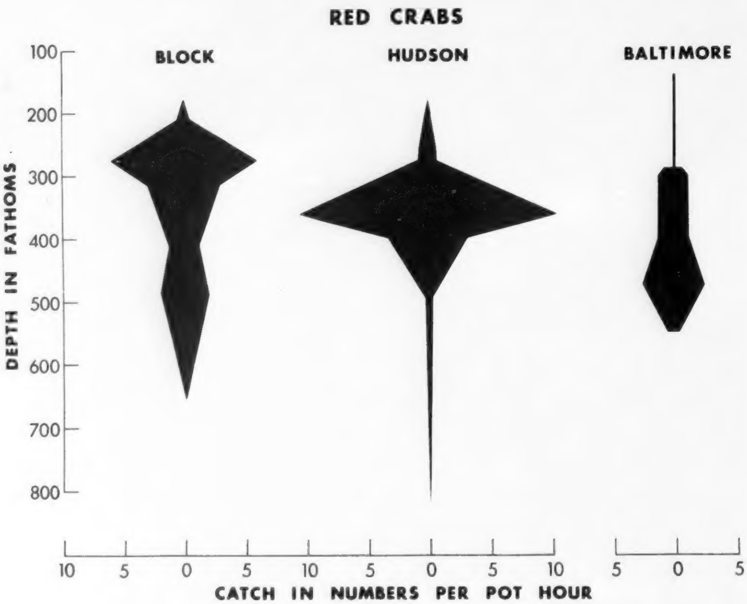


Figure 2.—The red crab (top) with a graph showing experimental catch rates at three locations off the coast of the northeastern United States. Red crabs sometimes reach a weight of more than 2 pounds. Most of the catch probably average 1.5 pounds. The crab depicted has a carapace width of more than 6 inches.

pounds, ocean quahogs with a potential of at least 100 million pounds, and red and Jonah crabs with a possible catch in excess of 10 million pounds, offer significant opportunity for increased landings. Besides these, various other kinds of fish such as dogfish, grenadier, saury, sea robins, etc. offer additional opportunities. Full utilization of fish presently caught, but not landed because of low value or little market acceptance, could add significantly to vessel and fishermen earnings. A quantity approximately equal to 50 to 75 million pounds, 20 to 30 percent of present trawl landings, is now thrown overboard. Discarded species often include: small silver hake, red hake, small butterfish and flounders, ocean pout, dogfish, and quantities of other species (Fig. 1).

NOAA has responded to this challenge by implementation of a comprehensive joint government/industry effort to increase the utilization of latent and underutilized New England fish stocks.

OBJECTIVE

To develop at least a $3 million per year industry, in sales of processed products, within 3 years, for the three targets—squid, crabs, and discarded fish—through development and demonstration of the technical and economic feasibility of harvesting, processing, and marketing. It is anticipated that industries for these products collectively will further expand to the $10 million per year level by the end of 5 years. Part of the project benefit will be derived through the transfer of excess effort from overfished stocks to the resources indicated.

PROGRAM APPROACH

This cooperative industry/NOAA effort, resulting from several months of joint planning, represents a multidisciplinary approach which will draw upon the resources of NMFS and the industry.

A working group has been formed, consisting of six key industry advisors, each representing significant geographic and operating segments of the industry. Officials of the marine fisheries agencies of the States of Maine, Massachusetts, and Rhode Island also participate in a supplementary capacity.

A Program Manager has been appointed by NMFS to oversee projects and to supply the group with access to programs and expertise available within NMFS. Contact with other agencies (i.e., Sea Grant, National Science Foundation, States, and various universities) and individuals who might make effective contribution has also been established.

Through a series of group discussions and review of existing material, agreement was reached concerning problem definition and priorities for target species. In addition to NOAA/NMFS reprogrammed funds totaling $400,000 made available to the pro-

Figure 3.—An experimental 18-hour set of a modified Alaska style king crab pot captured more than 800 pounds of red crab. Typically large offshore style lobster pots catch about 40 pounds per 24 hours' fishing. The New England Fisheries Development Program is working with industry to develop more efficient pots.

gram, numerous ongoing NMFS activities have been identified as contributing to the project and are being coordinated with specific program objectives. Cooperating NMFS elements are the Northeast Utilization Research Center in Gloucester, Mass., the Northeast Fisheries Center—Woods Hole, Mass., and the Marketing, Surveillance, Statistical, Extension, and Administrative personnel of the NMFS Northeast Region. On occasion assistance from other NMFS units both within and outside the region is called on. Industry has also demonstrated a willingness to contribute to vessel time, use of equipment and facilities, and labor.

Each "underdeveloped" fish stock has a unique set of problems of varying magnitude, generally related to the economics of harvesting, processing, or marketing. The target species for 1973-1975, red and Jonah crabs, mixed species (incidental catch), and squids, were selected because it was believed they can be caught by New England vessels with minimum modification to gear, and the obstacles holding up development appear tractable within the minimum budget available.

Developmental efforts will be tailored to the needs of each species and include activities such as: reviews of existing data on resource availability and harvesting technology to establish availability and optimum catch rates; development of mass handling and sorting methods for vessels and shore plants; investigation of processing technology and product engineering problems as necessary to permit efficient preparation of traditional as well as new products; and marketing studies to determine acceptance of various product forms in domestic and export markets.

Red and Jonah Crabs

The red crab, *Geryon quinquedens*, (Fig. 2) ranges from southeastern Nova Scotia to Cuba. It is abundant on the continental slope off the Middle and North Atlantic states. The extent of the red crab resource was only realized in the 1950's when it was encountered by fishermen fishing for offshore lobster (*Homarus americanus*). At least two other species of red crab (*Geryon* sp.) occur in Atlantic waters, including some ranging to South America, Africa, and Europe.

The red crab has not been heavily exploited in the past owing to a lack of processing capability, relative resource inaccessibility (deep water), and a lack of established market.

Red crabs are generally found where the water temperature is between 38° and 42°F. South of New England, the crabs are found at depths of about 170 fathoms and the larger concentrations appear at depths of 250 to 500 fathoms. At some locations the crabs will be found at depths to 1,000 fathoms.

The red crab is commonly caught along with lobsters in deep-water lobster pots. Some crabs are caught by trawlers dragging for lobsters. Exploratory fishing with Alaskan-style crab traps has also met with good success (Fig. 3).

In the northwest Atlantic an experimental fishery for the red crab was conducted from Nova Scotia during 1970 and 1971. This effort was discontinued. In 1973 two pilot process-

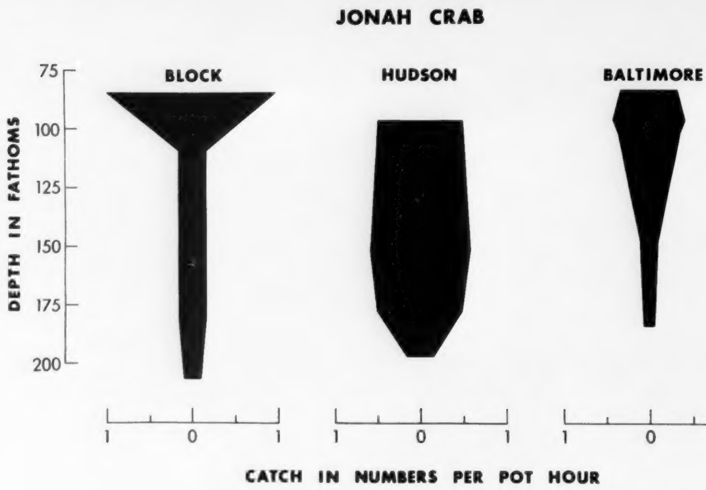


Figure 4.—The Jonah crab, sometimes reaching a weight of more than 1.5 pounds, is closely related to the Dungeness crab of the Pacific Northwest. This resource is broadly scattered over the continental shelf area off the eastern portion of the United States. The catch rates indicated are from experimental fishing by *Delaware II* near Block, Hudson, and Baltimore Canyons in 1971.

ing operations were undertaken in southern New England; a third was added during early 1974. These facilities received intermittent landings from a number of deep-water lobster fishing vessels.

There are many questions which must be answered in the development of this fishery. Possibly the most important is the extent of the resource and its ability to withstand heavy exploitation. It is probably reasonable to suggest a modest start with, say, 4-6 vessels producing a total of about 5 million pounds of live red crab. Careful monitoring should provide background for modification of this total as the resource condition and fishery dictate. Early experience also suggests that warm-weather mortality on vessels and ashore is a major problem. Other important considerations include the possible ability to transport live crabs over considerable distances by truck or other means. Some plans to address these critical areas have been developed.

The Jonah crab, *Cancer borealis*, ranges from Nova Scotia to the South Atlantic states but is probably most abundant off the New England and Middle Atlantic coasts. It has scarcely been exploited commercially, primarily because of a lack of processing capability, and lack of interest on the part of the fishermen.

Jonah crabs (Fig. 4) are found from low-tide level to depths over 100 fathoms with larger crabs being found at greater depths. They appear to be abundant between Georges Bank, Mass., and Cape Hatteras, N.C. Owing to the broad dispersion of the resource, some suggest that the Jonah crab resource is substantially greater than that for red crabs.

Jonah crabs are commonly caught along with lobsters in lobster pots, and the few individuals who fish exclusively for these crabs in New England often use modified lobster pots instead of crab pots. Some of these crabs are also taken by trawl gear when fished over the continental shelf. Recently lobster and trawl fishermen have been landing the larger Jonah crabs taken while fishing for other species.

Program Highlights—Red and Jonah Crabs

1. Working with industry (New Bedford, Mass.; Galilee, R.I.; Gloucester, Mass.) on vessel and shore handling techniques with particular reference to mortality.
2. Looking into modification of crab gear (traps) to optimize crab fishing techniques.
3. Working directly with industry to meet processing and production problems as they develop.
4. Establishing contract arrangements (State of Rhode Island) to acquire biological and related data on resource as it is extracted.
5. Working with the Northeast Fisheries Center (Woods Hole) to establish size and potential of resource.
6. Maintaining an overview of marketing picture.
7. Developing conceptual design for red crab meat extraction (picking) machine.

Long- and Short-finned Squids

Long-finned squid (Fig. 5) range from Nova Scotia to the Gulf of

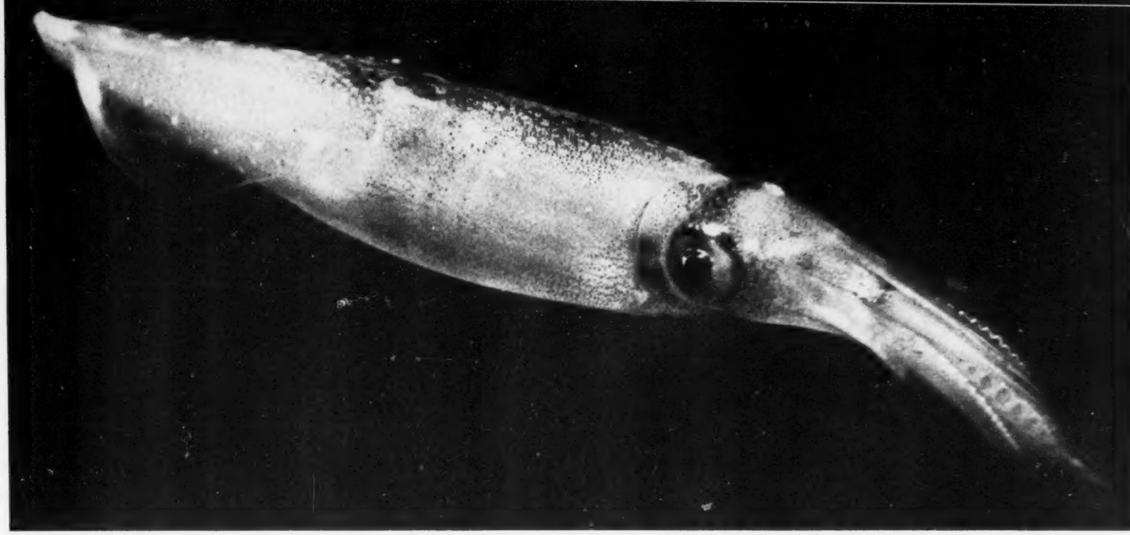


Figure 5.—The graceful long-finned squid in life is the object of a growing fishery off the eastern United States. Foreign trawlers take heavy tonnage of this species during the winter, when temperature conditions aggregate the squid near the edge of the continental shelf. The species is of interest for purposes other than food. Major contributions to neurophysiological knowledge have developed as a result of work on the giant nerve fibers of this species.

Mexico. They are essentially an animal of the continental shelf distributed inshore (in New England) from May to November and in deeper water for the remainder of the year.

Historically, U.S. fishermen have taken some squid as incidental catch while fishing for other species. Trap nets sometimes took large amounts for short periods in the spring and early summer when squid were abundant along the shore. Incidental quantities of squid have also been taken by vessels operating trawls between Cape Cod and Cape Hatteras. Since about 1968 a number of foreign nations have been harvesting squid along the edge of the continental shelf in the general vicinity of Hudson Canyon. Japan, Spain, Italy, and others have been taking substantial amounts of squid using trawl gear. During recent months, our own fishermen have been directing their efforts to squid as traditional fish species become less available and markets for squid begin appearing. Domestic East Coast production for the 4-year period 1970-1973 has doubled, from just over 1 million pounds to well over 2 million in 1973.

During January 1974 the New England Fisheries Development Program chartered a New Bedford trawler, the *Valkyrie*. About 24 days' fishing near Hudson Canyon produced over 168,000 pounds of squid. Some of this was prepared for sale overseas (in Europe) and some entered domestic markets.

The value of squid as food in this country has never been fully realized and it is considered an underharvested resource. The demand for squid will grow, however, as consumers become aware of this delicacy. Because squid are short-lived, there can be more intensive harvesting than in the case of long-lived or overfished species. Adequate consideration must be given to proper management of the resource, however, to avoid overfishing and to assure a continuing supply.

Squid is considered a gourmet or specialty item and has long been popular with Mediterranean, Oriental, and Mexican cooks. Squid has a delicate flavor and is delicious when fried or baked with a stuffing and may also be used in salads, sauces, or combination dishes. Whole squid is available fresh in some areas and frozen in most.

The short-finned squid are directly comparable to the long-finned squid discussed above. Principal differences have to do with the shape and size of the fins (which are shorter) and the color, which tends to be darker (rather rusty in hue) than that of the long-finned squid.

Short-finned squid are considered to be oceanic animals during a part of their (short) life history. In Newfoundland the inshore appearance of the short-finned squid can be expected in summer. Newfoundland fishermen traditionally took quantities of this species with squid jigs during this period. Also, in the Newfoundland area large quantities of this squid are consumed by blackfish (or "pilot whales"). Southwest of Newfoundland short-finned squid can be locally abundant as caught by trawls. This has been the case during May and June along the southern portion of Georges Bank and westerly along the continental shelf.

"Jigs" have been the most important traditional fishing gear for this species. Traps along the shore may occasionally take large quantities, but this is irregular. Recently (1973) trawl catches by Polish vessels off Southern New England have been substantial. Intermittent quantities are sometimes available during the summer in the general vicinity of Cape Ann. Little is known about the ability to catch these in quantity.

South of New England a rapidly developing fishery has been prosecuted primarily by the Spanish (see Fig. 6). Experimental fishing by the Japanese for this species has included the use of lights to attract and aggregate these animals (Fig. 7).

Similar observations which were made with respect to the long-finned squid probably apply for this species. Traditionally large quantities of the short-finned squid were caught and sold as longline bait (cod fish) in the Northwest Atlantic waters. Some has been used in more recent years by the Japanese as longline tuna bait. There is a strong suggestion that short-finned

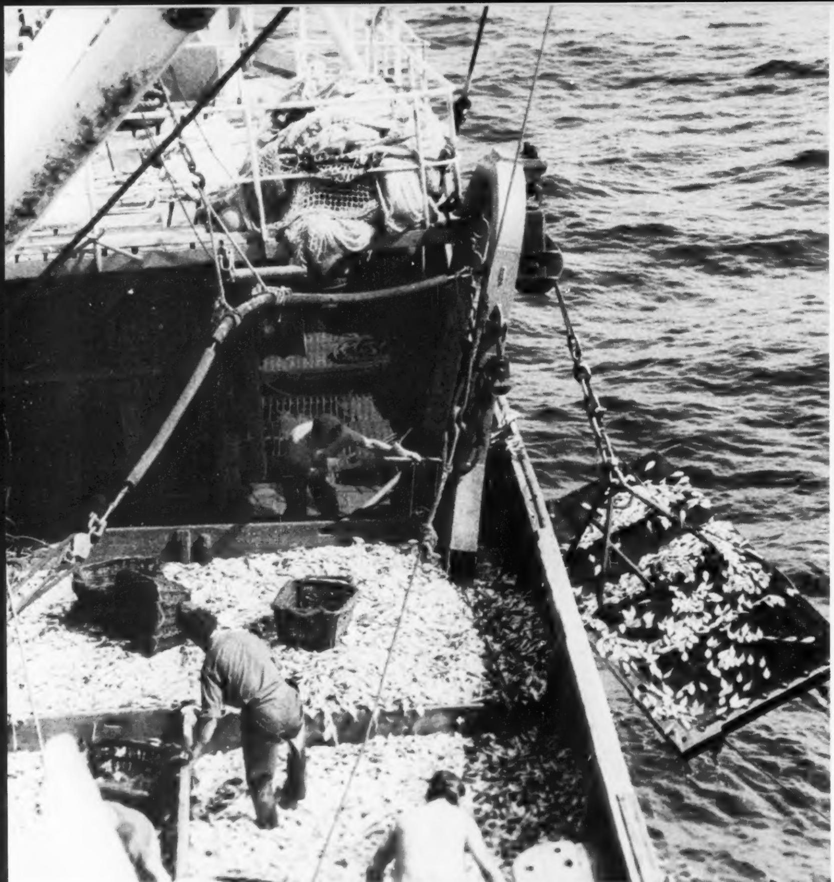


Figure 6.—About 8 tons of mixed squid and small butterfish on deck of a Spanish side trawler near Cape Hatteras in the fall of 1973. Spanish fishing efforts on long- and short-finned squid have dramatically increased in 1973 and 1974. There is some reason to expect even further developments in this acceleration of the squid harvest.

squid are as acceptable as the long-finned variety as food. Ultimately, this will have to be demonstrated in the market place.

At present there is speculation regarding the possibility of developing a U.S. fishery for squid. There is only little U.S. experience in the Northwest Atlantic waters from which judgments can be made. The Japanese and others have an established fishery for squid in the North Atlantic and full evaluation will be made of the experience developed in this fishery with application to our needs. With a carefully planned experiment it may be possible to determine the feasibility of a seasonal inshore fishery directed primarily for squid. Quantification (vessel involvement, employment, export trade) cannot be realistically done at this time.

Program Highlights—Squid

Long-finned

1. Fishing demonstration studies conducted in cooperation with industry (New Bedford).
2. In conjunction with 1 (above), conducting experiments on holding of squid in ice and frozen form (shelf life).
3. Working with gear technologists at the University of Rhode Island in development of improved squid fishing gear.
4. Looking into foreign and domestic market opportunities. Some cooperative effort with industry in product form development.
5. Looking into potential for improved harvesting technology; i.e., light attraction.
6. Refining estimates of stock potential—Northeast Fisheries Center (Woods Hole).

Short-finned

1. Planning demonstration fishing.
2. With studies on long-finned variety, will examine potential for light attraction in southern New England.
3. Looking into foreign and domestic market potentials.

Mixed Species

Wherever trawl operations are conducted along the continental shelf throughout the New England area a substantial portion of the catch is discarded. At some ports those fish normally discarded are taken ashore for use as industrial fish. At other locations fish not accepted in the market as food are taken for use in pet food. More recently, consideration is being given to the use of certain species as food for zoos and aquariums.

As a result of the adoption of techniques used in the meat packing industry, it has become possible to inexpensively separate fish flesh from the skeletal parts of dressed fish. This process opens the potential for extensive use of a great variety of species now discarded.

Controlled studies are needed to determine the best approach for handling at sea bulk catches of fish, some of which may be utilized in the preparation of minced fish blocks. In 1974 a vessel was adapted to conduct pilot operations with a suitable system. Research will also be necessary to develop an automated processing line capable of heading and gutting large quantities of small irregular sized fish.

If bulk handling at sea and automated processing of these mixed species becomes practical, it appears quite certain that a large portion of the catch heretofore discarded or sold as industrial fish may be available as food fish, thereby raising its value up to five times (over the price of industrial fish).

The potential benefits (income) to a large percentage of our trawler fleet could increase dramatically, if the research outlined can be accomplished.

A world shortage of supplies of traditional blocks (i.e., cod) used in processed fish has caused a rapid rise in price and substitution of other species (Alaska pollock and silver hake). In the past year a large percentage of the fish blocks utilized have been manufactured from minced fish. A fer-

Figure 7.—On board an experimental Japanese squid fishing vessel south of Nantucket Island in the fall of 1973. This method utilizes lights to attract and aggregate the squid at night, after which they are harvested with automatic jigging devices, shown here mounted on the rail. The same basic approach was scheduled for experiment in inshore application during 1974.

tile climate exists for introduction of other species (Fig. 8), possibly even mixtures of species if certain technical problems can be worked out.

Program Highlights— Mixed Species

Mixed species include: red, silver, white hakes; ocean pout; small flounders, butterfish and other species; dogfish; and others.

1. Cataloging and estimating resource stock size and availability in progress. (Gloucester—Woods Hole).
2. Conducting feasibility experiments on techniques for bulk handling of fish at sea. Evaluating tests. (Pt. Judith—Gloucester).
3. Looking into modification and

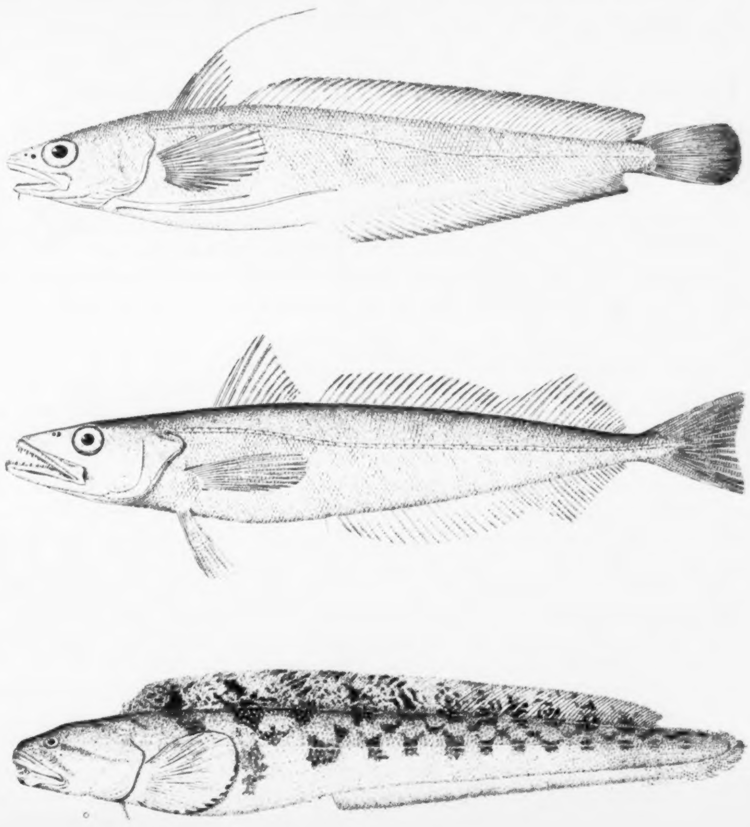


Figure 8.—(Top to bottom) Red hake (*Urophycis chuss*), silver hake (*Merluccius bilinearis*), and ocean pout (*Macrozoarces americanus*) all have some potential for exploitation under the mixed species heading. Initial experiments with minced flesh from silver hake have yielded a number of attractive products.

development of high volume unloading techniques.

4. Considering techniques for sorting and otherwise handling diverse small fish ashore.
5. Working with industry to modify existing flesh-bone separators for use with local species: i.e., whiting (silver hake).
6. Have developed contract with Connecticut College for economic evaluation of mixed species parameters.
7. Through marketing and liaison channels have worked to alert producers and processors of plans, progress, and potentials.
8. Have active plans for marketing survey to determine the potential markets in animal feeding (zoological parks, aquariums, seaquariums, and related).
9. Pilot studies initiated on use of containers for preservation of fish.
10. Looking at methods of skinning dogfish shark.

THE FUTURE

It is generally agreed that most Northwest Atlantic finfish stocks are now exploited near or beyond their capacity. It would appear that if any are not, the momentum built up in the present fisheries will almost certainly absorb readily available "surplus" within the next several years. It appears to follow that any new potential to support growth or maintenance of fishery production will probably come from "underdeveloped" resources. In most cases the exploitation of these requires a comparatively high input of risk, fishing and processing technology, and marketing. These must be blended into a coordinated effort; it is this approach in spirit which dominates the New England Fisheries Development Program.

REFERENCES

Anonymous. 1971. Delaware II assesses shellfish resources south of New England. Commer. Fish. Rev. 33(3):9-13.

Haefner, P. A., Jr., and J. A. Musick. 1974. Observations on distribution and abundance of red crabs in Norfolk Canyon and adjacent Continental Slope. Mar. Fish. Rev. 36:31-34.

Holmsen, A. 1973. Potential utilization of underexploited species in southern New England. Univ. R.I., Mar. Memo. Ser. 32.

Martin, R. E. (editor). 1972. Oak Brook seminar—mechanical recovery and utilization of fish flesh, p. 1-270. Natl. Fish. Inst., Wash., D.C.

Meade, T. L., and G. W. Gray, Jr. 1973. The red crab. Univ. R.I., Mar. Tech. Rep. 11.

Rathjen, W. F. 1973. Northwest Atlantic squids. Mar. Fish. Rev. 35:20-26.

MFR Paper 1100. From Marine Fisheries Review, *Vol. 36, No. 11, November 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1101

Riddle of Bering Sea Soundings Resolved

FELIX FAVORITE

ABSTRACT—Although a Soviet map and Japanese nautical chart show isolated soundings in excess of 300 m on the Bering Sea shelf about 160 km northwest of St. Matthew Island, evidence indicates that actual depths are less than 200 m and no conspicuous depression of the sea floor exists in that area.

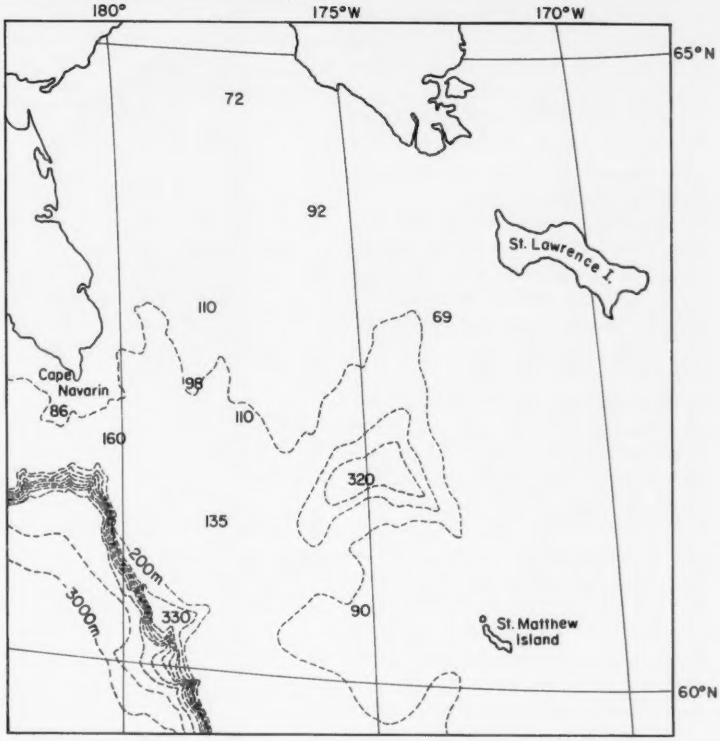
Almost a decade ago, when writing an article on the oceanography of the Bering Sea basin (Favorite, 1966), I was surprised to discover the paucity of soundings on the broad continental shelf in the eastern part of the sea indicated on U.S. nautical charts. After consulting several Federal agencies and oceanographic groups and not discovering any conclusive evidence to the contrary, I accepted the existence of a depression in excess of 300 m northwest of St. Matthew Island as shown on one panel of a large map of the USSR (Fig. 1) printed by the Omsk Cartographic Plant, Main Administration of Geodesy and Cartography, (27 June, 1955, 3,000 copies) that I had acquired. Recent extensive exploitation of fish stocks in the Bering Sea by foreign mothership fleets (total fish catch per year in the Bering Sea exceeds the total catch per year of all U.S. fisheries) prompted renewed interest in environmental conditions over the continental shelf, and further evidence that such a depression does not exist has been obtained.

The eastern Bering Sea shelf, which extends over 600 km seaward of the west coast of Alaska, is not only the widest in the world but generally devoid of bathymetric irregularities. The gentle seaward slope, interrupted only by several isolated island groups, is so slight that if sea level were reduced and man were able to walk on the shelf, the terrain would appear flat in all directions. Ice cover during winter lowers water temperatures to nearly $-2°C$. In spring, extensive runoff from coastal rivers and increased insolation increases the stability of the surface layer and retards the penetration of summer heating into the water column, resulting in an annual range of temperatures at depths greater than 75 m of only a few degrees. In the area between St. Matthew and St. Lawrence Islands, negative temperatures can occur year round; thus, evidence of a depression of the sea floor in excess of 300 m as shown in the Soviet map implied the existence of not only an unusual bathymetric feature, but also an area of year-round temperatures near the ice point ($-2°C$), a rather unique, isolated, benthic environment.

For nearly 200 years man has tra-

Felix Favorite is a member of the staff of the Northwest Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Blvd. E., Seattle, WA 98112.

Figure 1.—Bathymetry and individual soundings (m) as indicated on a portion of a Soviet map constructed in 1951-52 and printed in 1953 showing detailed contours of a depression northwest of St. Matthew Island.



versed this area while engaged in various fishing activities, yet published soundings are still quite sparse. Captain James Cook, during a search for a Northwest Passage, is credited with being the first to sail along the eastern Bering Sea coast. He accomplished this in 1778, almost 50 years after I. Fedorov transited the Bering Strait and discovered that North America was separated from Asia by only about 100 km. During the mid-19th century, numerous New England whaling vessels sailed through the shallow strait, which was surveyed during a cruise of the USCS *Yukon* in 1880 and shown to have a maximum depth of about 50 m (Dall, 1882). Although soundings and construction of bathymetric charts of U.S. coastal waters have been carried out historically by the extant U.S. Coast and Geodetic Survey, extensive soundings in the southeastern Bering Sea were obtained by the U.S. Fish Commission's steamer *Albatross* at the end of the last century; and, in order to make these data available quickly to fishermen, the Commission actually published a chart—U.S. Commission of Fish and Fisheries Chart No. 1, Alaska Region (Rathbun, 1894). The edge of the continental shelf (100 fathom line) was indicated well west of St. Matthew Island, but only a few soundings were indicated in that area.

Surprisingly, little new information in the area northwest of St. Matthew Island is afforded even on present day U.S. nautical charts. The charts available to me in 1965 have been revised and therefore not retained, but an indication of the data available at that time can be made. U.S. Hydrographic Office Chart No. 0068, Bering Sea and Strait (14th ed., Sept. 1943; rev. Aug. 1950) indicates two isolated soundings (Fig. 2) of 40 and 42 ftm (73 and 77 m) near lat. 61°35′N, long. 175°W and 174°W, respectively,

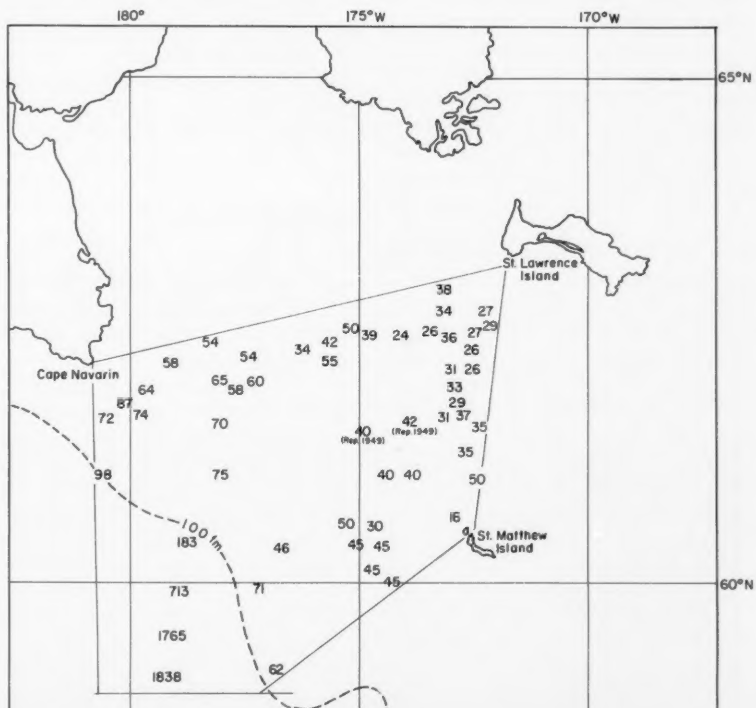


Figure 2.—Bathymetry and individual soundings (ftm) as indicated on a portion of H.O. Chart 0068 (14th ed; rev. Aug. 1950). Present day charts show no additional soundings.

with the notation "Rep (1949)." On the current edition of this chart (now No. 68—14th ed., Sept. 1943; Revised 4/28/69), the notation is no longer evident, but no additional soundings are indicated. Identical soundings are also shown on H. O. Chart No. 523 (Revised 11/12/73). U.S. Coast and Geodetic Survey Chart No. 9302, Bering Sea, Eastern Part (17th ed., rev. 1956) also shows these two soundings but without notation. Although none of these charts indicated the presence of any depression, the paucity of soundings did not necessarily preclude its possible existence.

Supporting evidence for the depression is still evident on the Japan Maritime Safety Agency Chart No. 804, Bering Sea, (1938, Rev. 1972), which indicates soundings of 320 m near lat.61°35'N, long.175°W, and 318 m near lat.61°W, long.174°W. No other data are given within 150-200 km to the north or west of these soundings to indicate the extent of depths greater than normal shelf depth (200 m), and the chart bears the inscription "Compiled chiefly from the British Chart, 1937 with corrections from the U.S.S.R. and United States Charts."

In October 1973, during a visit to the Far Seas Fisheries Research Laboratory, Shimizu, Japan, I had an opportunity to discuss the possible existence of this depression with Captain Takeji Fujii, RV *Oshoro Maru*, Faculty of Fisheries, Hokkaido University. For over two decades annual summer training cruises have been conducted in the Bering Sea aboard the *Oshoro Maru* and, from 1964-68, cruises had been conducted in the general area of the supposed depression. Captain Fujii kindly compiled and forwarded to me the soundings that had been obtained. No sounding in excess of 100 m was recorded, and two are particularly significant: on 3 August 1967 a sounding of 76 m was obtained near lat.61°33'N, long. 173°50'W; and, on 4 August 1968 a sounding of 91 m was obtained near lat.61°31'N, long.175°00'W. Thus, it would appear that another riddle of the sea has been resolved, particularly, in view of the fact that recent Soviet maps do not show any evidence of the depression. However, a potentially interesting fishing ground has been eliminated.

LITERATURE CITED

Dall, N. H. 1882. Report on the currents and temperatures of Bering Sea and adjacent waters. U.S. Coast and Geodetic Survey, Rep. 1880, App. 16:297-340.

Favorite, F. 1966. Bering Sea. *In* R. W. Fairbridge (editor), Encyclopedia of oceanography, Encyclopedia of Earth Sciences Ser., Vol. 1, p. 135-140. Reinhold Publ. Corp., N.Y.

Rathbun, R. 1894. Summary of the fishery investigations conducted in the North Pacific Ocean and Bering Sea from July 1, 1888, to July 1, 1892, by the U.S. Fish Commission steamer Albatross. Bull. U.S. Fish. Comm. 12:127-201.

MFR Paper 1101. From Marine Fisheries Review, Vol. 36, No. 11, November 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.

MFR PAPER 1102

Fishing intensity over artificial reefs is thousands of times that over natural habitat.

Effects of Artificial Reefs on a Marine Sport Fishery off South Carolina

CHESTER C. BUCHANAN, RICHARD B. STONE, and R.O. PARKER, JR.

ABSTRACT—Two artificial reefs created recreational reef fisheries off Murrells Inlet, S.C. These reefs attracted additional anglers to the area and provided better fishing than existed before the reefs were built. However, fishing success was not as high over the artificial reef as over nearby live bottom habitat because of high fishing intensity on the small area covered by reef material. The reefs did not increase surface fishing success.

INTRODUCTION

By providing or improving reef-fish habitat accessible to anglers, construction of artificial reefs affords considerable promise for enhancement of recreational fishing. Before the full potential of artificial reefs for recreational fishing can be realized, we must determine their impact on fishing success and effort. Several investigations have considered these effects, but their findings were inconclusive (Buchanan, 1972; Elser, 1960; Turner, Ebert, and Given, 1964; Wickham, Watson, and Ogren, 1973). The purpose of this study, which encompassed the summer (June-September) of 1972 and the summer and fall (June-November) of 1973, was to compare fishing success, species composition, and fishing effort on artificial and natural habitats off Murrells Inlet, S.C. Results of the survey in the summer and fall of 1973 are presented and compared with results from the 1972 survey reported by Buchanan (1973).

There are two artificial reefs located off Murrells Inlet: Paradise Artificial Reef, begun in 1963 and located 3 miles from the Inlet; and Pawleys Island Artificial Reef, begun in early summer of 1973 and located 5 miles from the Inlet (Fig. 1). Paradise Artificial Reef, the larger of the two, is composed of several thousand car tires and four vessels. Pawleys Island Artificial Reef consists only of two landing craft. The reefs, together, cover about 0.01 square mile and protrude 1 to 10 feet above the bottom. The reefs are rich with sessile and motile invertebrates such as tunicates, barnacles, oysters, sponges, hydroids, sea urchins,

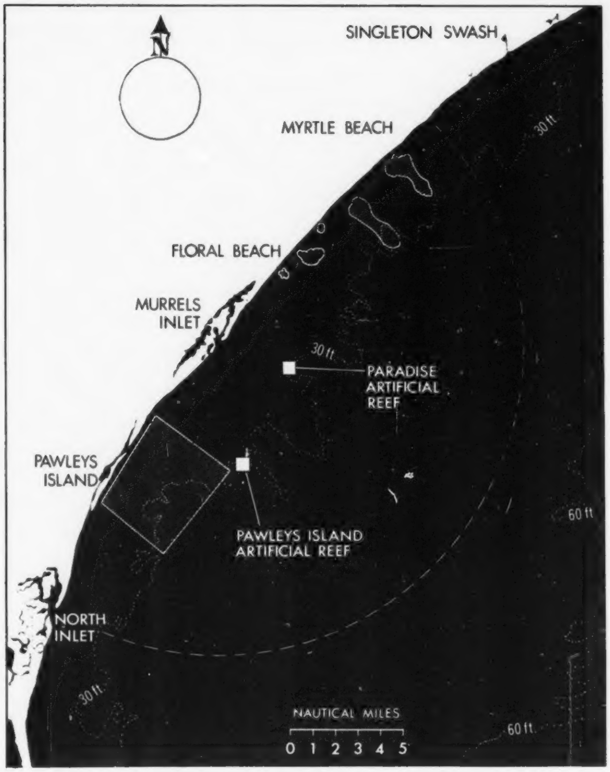


Figure 1.—The location of artificial reefs and live bottom (shaded area) within the survey area (dotted line) off Murrells Inlet, S.C.

crabs, and shrimp. Only private boat anglers use these reefs.

According to Struhsaker (1969), natural bottom off South Carolina is classified as either coastal or live bottom habitat. Coastal habitat, characterized by smooth, sandy-mud bottom, covers about 264 square miles of our survey area. Live bottom, characterized by low profile rock outcrops rich with sessile invertebrates, such as sponges, soft corals, and sea fans (Fig. 2), is restricted to several locations within the survey area and collectively totals about 22 square miles.

METHODS

Fishing effort, measured in angler-hours, was calculated from boat counts and number of anglers and angler-hours per boat. Boat-days each month were estimated by expanding the number of private boats leaving the Inlet during stratified randomly selected periods. Boats were counted by personnel of the South Carolina Wildlife Resources Department. They sampled 6 week days and 2 weekend days each month. Each day was divided into 2 half-days, from 0600 to 1200 hours and 1200 to 1800 hours. The number of anglers was estimated by multiplying the estimated number of boat-days by the mean number of anglers per boat. The number of angler-hours was estimated by multiplying the estimated number of anglers by the mean number of hours fished per angler, obtained from dockside interviews.

We interviewed anglers at dockside to determine where they fished, what baits they used, the number of hours they fished, the number of fish they caught and the composition of their catch (Fig. 3). Using a systematic sampling design, we interviewed anglers during 5 consecutive days (3 week days and 2 weekend days) each month from 1100 hours to 1800 hours. We counted and identified the fish of each party we interviewed. We used CPUE (catch per unit of effort), calculated from catch and fishing effort data, as a measure of fishing success.

To simplify our presentation we combined data for similar species. We called black sea bass (*Centropristis striata*) and rock sea bass (*Centropristis philadelphica*)—sea bass; summer flounder (*Paralichthys dentatus*) and southern flounder (*Paralichthys lethostigma*)—flounder; pinfish (*Lagodon rhomboides*), spottail pinfish (*Diplodus holbrooki*), longspine porgy (*Stenotomus caprinus*), and scup (*Stenotomus chrysops*)—porgy; weakfish (*Cynoscion regalis*) and spotted seatrout (*Cynoscion nebulosus*)—seatrout, and blue runner (*Caranx crysos*) and greater amberjack (*Seriola dumerili*)—jack.

SURFACE FISHING

We estimated that private boat anglers expended over 30,000 angler-hours (64 percent of the total effort)

Figure 2.—Patches of live bottom scattered throughout the survey area provide a hard, irregular habitat for many species of demersal fishes.

Chester C. Buchanan, Richard B. Stone, and R. O. Parker, Jr. are members of the staff of the Atlantic Estuarine Fisheries Center, National Marine Fisheries Service, NOAA, Beaufort, NC 28516.

Figure 3.—Biologist (right) interviewing an angler at dockside for catch and effort data.

for pelagic species off Murrells Inlet (Fig. 4). Eighty-nine percent was expended over coastal habitat, 9 percent over the reefs, and 2 percent over live bottom. Peak effort occurred over coastal habitat in August and over the reefs in June and September. Live bottom was fished only in August and September.

CPUE for pelagic fishes was higher over coastal habitat than over the reefs (Mann-Whitney U test: U = 1,334, $P < 0.00003$). On the average during the season, private boat anglers caught 1.9 fish per angler-hour over coastal habitat and only 0.1 fish per angler-hour over the reefs. We did not compare CPUE over coastal habitat to that over live bottom habitat because of insufficient data. Monthly CPUE's, while fluctuating considerably, were consistently higher over coastal habitat than over the reefs (Fig. 5).

We estimated that private boat anglers caught nearly 52,000 fish representing 10 species (Table 1). Most of the species caught were pelagic. As in 1972, Spanish mackerel (*Scomberomorus maculatus*) constituted over 90 percent of the catch from each habitat type. Although they were caught throughout the season, the largest catches were made in mid-season. Bluefish (*Pomatomus saltatrix*), caught only over coastal habitat, were the second most numerous pelagic species taken. They first appeared in the catch in August and gradually increased in number until November when they represented 99 percent of the catch.

Anglers expended nearly 14,000 more angler-hours seeking pelagic species during the summer of 1973 (June-September) than they did in the summer of 1972 (Table 2). Coastal habitat received nearly all the increase.

Fishing success was not the same for both summers. In 1973 anglers had their highest CPUE over coastal habitat, whereas in 1972 they had about the same CPUE over all habitats. CPUE over artificial habitat was higher in 1972 and 1973: 0.1 fish per angler-hour in 1973 and 1.8 in 1972 (Mann-Whitney U test: U = 247, $P < 0.007$).

Our estimates of surface fishing success may not be appropriate for evaluating the reefs, since anglers do not randomly fish for pelagic recreational fishes, but visually search for surface schools. Thus, a system of controlled fishing over each habitat type may provide the most satisfactory method of evaluating reefs. Wickham, Watson, and Ogren (1973), using controlled fishing techniques, showed that midwater structures in the Gulf of

Table 1.—Estimated percentage of species caught by private boat anglers in 1973 while surface fishing different habitats: (A) artificial, (LB) live bottom, and (C) coastal.

Species	Habitat	Jun	Jul	Aug	Sep	Oct	Nov	Season
Bluefish	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	0.0	0.0	0.1	3.6	9.7	99.4	7.9
King mackerel	A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	LB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	13.8	4.1	0.5	0.4	9.0	0.0	1.0
Spanish mackerel	A	94.4	0.0	100.0	100.0	0.0	0.0	96.4
	LB	0.0	0.0	100.0	100.0	0.0	0.0	100.0
	C	83.9	93.9	99.3	96.0	80.6	0.6	90.5
Others	A	5.6	0.0	0.0	0.0	0.0	0.0	3.6
	LB	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	C	2.3	2.0	0.1	0.0	0.7	0.0	0.6
Estimated Number	A	240	0	19	101	0	0	360
	LB	0	0	134	78	0	0	212
	C	1,138	2,054	35,285	6,525	2,434	3,557	50,993

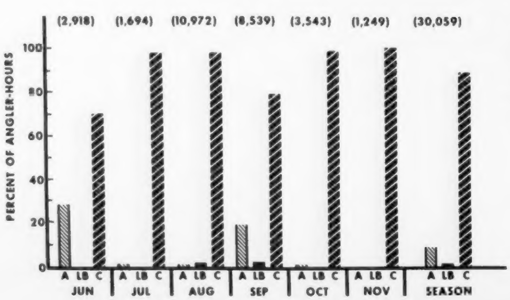


Figure 4.—Estimated number and percent of angler-hours expended by private boat anglers surface fishing over artificial (A), live bottom (LB), and coastal (C) habitats off Murrells Inlet, S.C., 1973.

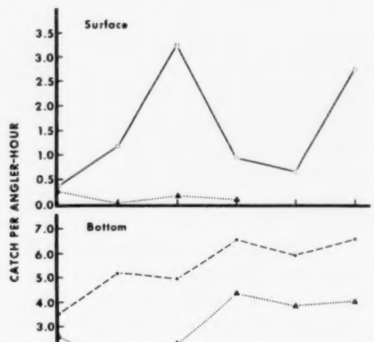


Figure 5.—Catch per angler-hour while surface fishing and bottom fishing (with cut bait only) over coastal (open circles), live bottom (solid circles), and artificial (solid triangles) habitats from June through November 1973.

Table 2.—Number of angler-hours expended off Murrells Inlet over artificial (A), live bottom (LB), and coastal (C) habitats, by method of fishing, and year, June - September.

Fishing Method	1972			1973			
	A	LB & C	Total	A	LB	C	Total
Surface	2,632 (23%)	8,810 (77%)	11,442	2,779 (11%)	505 (2%)	21,983 (87%)	25,267
Bottom	4,553 (47%)	5,134 (53%)	9,687	8,909 (70%)	2,927 (23%)	891 (7%)	12,727
Total	7,185	13,944	21,129	11,688	3,432	22,874	37,994

Table 3.—Bottom fishing intensity by habitat type, June-November, 1973.

Habitat	Angler-hours	Square miles	Angler-hours/ sq mile
Artificial	11,268	0.01	1,126,800
Live Bottom	4,379	22.00	199
Coastal	1,554	264.00	6

Mexico increased the CPUE of several pelagic recreational fishes.

Certain pelagic fishes, such as king mackerel (*Scomberomorus cavalla*) and little tunny (*Euthynnus alletteratus*), are attracted to a reef by the presence of prey fishes (i.e., scads, herrings), while other pelagic fishes, such as dolphin (*Coryphaena hippurus*), cobia (*Rachycentron canadum*), and greater barracuda (*Sphyraena barracuda*) are attracted by the structure (Wickham, et al., 1973). During our surveys of the reefs in 1972, we often observed schools of both scads (*Decapterus* sp.) (Fig. 6) and Spanish mackerel at or near the surface. But in 1973 we observed few schools of either species. Spanish mackerel are probably attracted to the scads rather than the reef structure and the poor success for that species over the reefs in 1973 may have been due to the low number of prey.

BOTTOM FISHING

We estimated that private boat anglers expended over 17,000 angler-hours (36 percent of the total effort) for demersal species from June through November 1973 (Fig. 7). Sixty-six percent was expended on the reefs, 25 percent on live bottom, and 9 percent on coastal habitat. Fishing intensity (angler-hours per square mile of habitat) on the reefs was almost 6,000 times that on live bottom and 200,000 times that on coastal habitat (Table 3). Anglers fished for demersal species on artificial and live bottom habitats during the entire season, expending their peak effort in September, and on coastal habitat from June through October, expending their peak effort in October. They fished more intensively on the reefs than over coastal or live bottom habitats, even though the reefs consisted of less than 0.01 percent of the survey area.

We found 30 species represented in the catch and estimated that anglers caught nearly 58,000 fish (Table 4). Most of the species caught were demersal. Nearly 97 percent were from the reefs and live bottom. Sea bass, porgy, and flounder constituted over 75 percent of the catch from artificial and live bottom habitats and only 3 percent of the catch from coastal habitat. The catch from live bottom was largely sea bass (55 percent) while the catch from the reefs was mostly porgy (Table 4). Sea bass accounted for a larger percentage of the monthly catch from live bottom than from the reefs. Porgy, which we observed on the reefs throughout the season, represented a larger and more consistent proportion of the monthly catch from the reefs than from live bottom (Table 4). No sea bass or porgy were reported caught over coastal habitat. Flounder represented nearly 22 percent of the catch from the reefs and less than 1 percent from live bottom. Bluefish was the most numerous species caught over coastal habitat (43 percent), even though they occurred in the catch only during September and October.

Sea bass, although appearing throughout the season in catches from artificial and live bottom habitats, were most abundant in early summer and again in fall (Table 4). On the basis of underwater observations, life history information (Cupka, 1972), and catch and effort data, we believe that immigration from surrounding areas during these periods caused peaks of abundance both on the reefs and in catches.

There were monthly differences in the relative composition of sea bass and porgy in catches from the reefs and live bottom. Porgy were more abundant on the reefs and sea bass more abundant on live bottom. These differences could be the result of: (1) the sea bass stock on the reefs being reduced faster by high fishing intensity than the stock on live bottom, (2) porgy having a greater affinity than sea bass for high profile objects,

Figure 6.—Scads schooling around Paradise Artificial Reef in 1972.

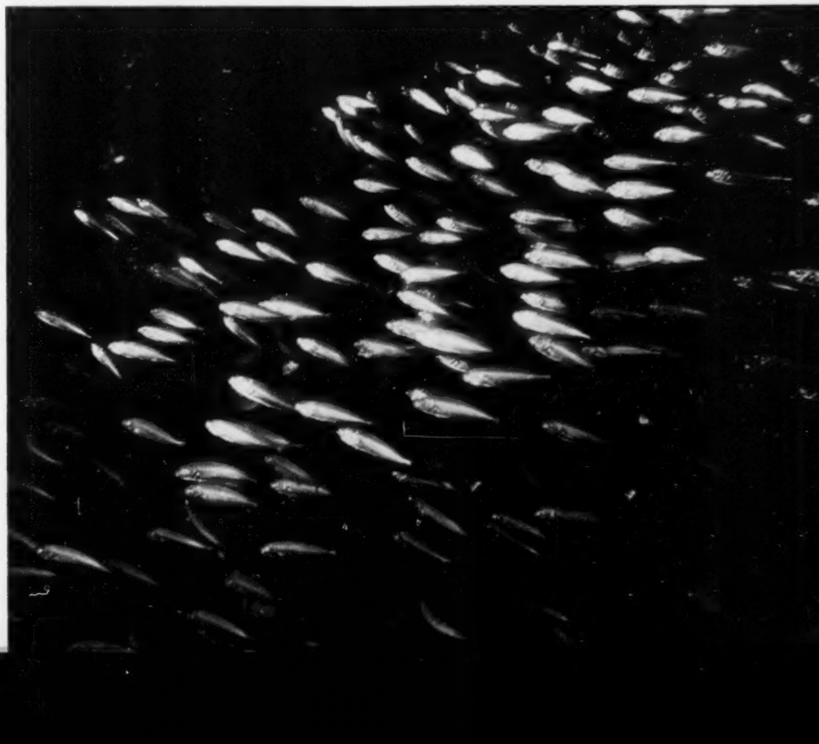


Table 4.—Estimated percentage of species caught by private boat anglers in 1973 while bottom fishing different habitats: (A) artificial, (LB) live bottom, and (C) coastal.

Species	Habitat	Jun	Jul	Aug	Sep	Oct	Nov	Season
Atlantic	A	0.0	0.5	2.9	0.0	0.0	0.0	0.4
croaker	LB	0.0	0.5	5.0	23.7	0.8	0.0	9.0
	C	0.0	0.0	0.0	0.0	6.1	0.0	5.2
Bluefish	A	1.9	2.4	0.0	2.0	1.1	0.0	1.5
	LB	0.0	0.0	3.5	0.0	0.0	2.5	0.8
	C	0.0	0.0	0.0	25.0	49.0	0.0	42.9
Flounder	A	10.1	33.3	16.5	38.8	5.5	0.0	21.6
	LB	2.7	2.3	0.0	0.3	0.0	0.0	0.5
	C	0.0	0.0	0.0	0.0	3.1	0.0	2.6
Pigfish	A	13.6	5.2	23.5	1.0	11.9	26.3	9.8
	LB	2.7	13.6	1.0	3.9	0.0	0.0	3.2
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Porgy	A	49.7	38.1	38.2	35.6	47.3	29.5	40.5
	LB	6.7	20.7	49.2	23.7	5.5	0.0	19.3
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sea bass	A	13.6	14.3	7.6	20.1	27.9	38.8	20.3
	LB	80.0	59.7	34.2	31.1	81.2	85.1	55.1
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Seatrout	A	2.8	1.0	6.5	0.2	1.3	0.0	1.6
	LB	0.0	0.0	2.5	14.8	10.0	8.3	8.8
	C	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sharks	A	3.5	1.4	0.6	0.0	0.4	0.0	0.8
	LB	5.3	2.8	1.0	0.0	0.0	0.8	0.8
	C	80.0	83.0	100.0	25.0	0.0	0.0	10.2
Others	A	4.8	3.8	4.2	2.3	4.6	5.4	3.5
	LB	2.6	0.4	3.6	2.5	2.5	3.3	2.5
	C	20.0	17.0	0.0	50.0	41.8	0.0	39.1
Estimated	A	4,156	3,417	3,259	10,394	7,117	1,936	30,279
Number	LB	987	2,992	3,812	8,742	6,265	2,931	25,729
	C	66	83	38	107	1,542	0	1,836

Table 5.—Bottom fishing statistics for anglers interviewed at dockside from June through November, 1973.

	Habitat Type					
	Artificial Bait		Live bottom Bait		Coastal Bait	
	Live	Cut	Live	Cut	Live	Cut
Number of angler-hours	180.5	378.8	0	234.3	0	88.3
Number of fish	368	1,116	0	1,343	0	115
Catch per angler-hour	2.0	3.0	0	5.7	0	1.3
Species	*Percent of Catch*					
Atlantic croaker	0.0	0.5	0.0	6.9	0.0	5.2
Bluefish	2.7	0.6	—	0.7	—	42.9
Flounder	67.0	2.5	—	0.6	—	2.6
Pigfish	0.5	14.7	—	3.0	—	0.0
Porgy	7.4	50.8	—	17.8	—	0.0
Sea bass	11.0	23.6	—	57.6	—	0.0
Seatrout	7.0	0.7	—	7.7	—	0.0
Sharks	1.3	0.9	—	1.0	—	10.2
Spanish mackerel	0.3	0.0	—	0.3	—	0.8
Others	2.0	5.3	—	4.0	—	38.2

such as the vessels on the reefs, and sea bass having a greater affinity than porgy for the low profile of live bottom, and (3) porgy having a greater preference than sea bass for encrusting organisms on the reefs.

Flounder, which appeared in the catch from June through October, were caught most frequently in the summer. This was also the period we observed their greatest abundance around the reef. We suspect flounder were as abundant on live bottom habitat as on artificial habitat and that the small catch on live bottom was due to a lack of a specific, live bait fishing effort for flounder.

We recognized two possibilities for bias in our estimates of CPUE's for bottom fishermen on different habitats. First, CPUE on a particular habitat could be influenced by the relative numbers of novice and experienced anglers, and second, CPUE for a particular species could be influenced by the type of bait used. We defined experienced parties as those with the largest catches and whose combined catch represented approximately 50 percent of the total bottom catch with cut bait (Rupp, 1961). Cut bait was defined as any kind of dead natural bait and live bait as any living bait.

The experienced fisherman's efficiency per unit of effort is greater than that of the novice fisherman, probably because he knows the area and is skilled in fishing. This would result in the CPUE for a habitat with a relatively large number of experienced fishermen being higher than the CPUE for a habitat with a relatively small number of experienced fishermen. Only 12 percent of the parties that fished over the reefs were experienced, as contrasted with 20 percent over live bottom. This difference probably is not large enough to affect our conclusion. The reefs attracted more novice anglers because they are easy to locate, are close to shore, are well buoyed, and have received much publicity in local news media during the past few years. Most of the live bottom patches are located farther from the Inlet and their exact positions are known to only a small group of fishermen.

To determine if the bait a fisherman used influenced the species composition of his catch, we compared the catch of reef fishermen using cut bait with the catch of those using live bait. Nearly 90 percent of the flounder were caught on live bait while 86 percent of the sea bass and 96 percent of the pigfish (*Orthopristis chrysoptera*) and porgy were caught on cut bait (Table 5). Since almost 32 percent of the reef fishermen's effort was with live bait and none of the live bottom fishermen used live bait, a higher catch of flounder would be expected on the reefs. Fishermen using cut bait averaged about 2.7 more fish per angler-hour over live bottom than over the reefs (Mann-Whitney U test: $U = 465.5$, $P < 0.003$) (Table 5). Monthly CPUE's for cut bait fishermen were consistently higher over live bottom than over the reefs (Fig. 5).

Over 3,000 more angler-hours were

expended bottom fishing in the summer of 1973 than in the summer of 1972 (Table 2). Effort on the reefs doubled between 1972 and 1973, whereas effort on natural habitat decreased by 25 percent.

CPUE of bottom fishermen on the reefs was about the same for both summers (Mann-Whitney U test: U = 1,063, P = 0.2946), but the relative composition of the catch was not (Fig. 8). Fishermen caught 3.0 fish per angler-hour in the summer of 1972 and 2.4 fish per angler-hour in the summer of 1973. The relative composition of pigfish and porgy (combined) in the catch differed by only 2 percent between summers. In 1973, jack decreased by 11 percent, sea bass by nearly 10 percent; flounder increased by 20 percent. The large number of flounder caught from the reefs in 1973 may have resulted from an increase in effort with live bait and an increase in the abundance of flounder. Although we did not separate effort by bait categories in 1972, we suspect that less than 25 percent of the effort was with live bait. During underwater surveys of the reefs, we observed that flounder were more abundant in 1973.

Fishing success in 1973 was better on the reefs than on coastal habitat and less productive than on live bottom. These differences were not observed in 1972 because of a possible masking effect caused by combining data from highly successful fishing over live bottom with data from relatively unsuccessful fishing over coastal habitat. The relative abundance of each species in the catch from natural habitat is not comparable between summers because the data from live bottom and coastal habitats were pooled in 1972.

Our estimates of bottom fishing success may not be appropriate for evaluating the reefs, since the reefs and live bottom were of different sizes and received different fishing intensities. We believe the efficiency of artificial reefs for enhancing a marine recreational fishery can best be evaluated by an experimental program of controlled fishing over natural and artificial habitats of equal size.

DISCUSSION AND CONCLUSIONS

The reefs off Murrells Inlet increased bottom fishing opportunities by providing a reef fishery within easy access of the Inlet. During the summers of 1972 and 1973, bottom fishing anglers expended nearly 50 percent or more of their effort on the reefs. Effort on the reefs, which probably was intensified as the result of publicizing the reefs in the local news media, increased nearly 100 percent between summers, while effort in the whole survey area increased only 32 percent. Even though the reefs covered considerably less surface area than live bottom, they received a fishing intensity several thousand times greater than that on live bottom. Coastal habitat received only a small portion of the effort.

We expected bottom fishing success to be similar over artificial reefs and live bottom since these habitats share many characteristics. However, fishermen caught fewer fish per angler-hour over the reefs than over live bottom. We believe the lower CPUE on the reefs resulted from the combined effects of high fishing intensity, numerous novice anglers, and the small area covered by the reefs. High fishing intensity caused greater competition

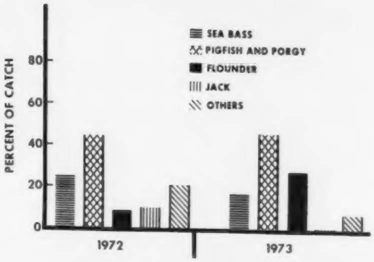


Figure 8.—Catch, in percent, of major species groups by private boat anglers bottom fishing on artificial habitat off Murrells Inlet, June-September 1972 and 1973.

among the reef fishermen. The lack of knowledge of the area and of fishing skills by novice anglers also reduced the overall CPUE. Replenishment of the reefs stock by immigration from surrounding areas will cushion the effect of high fishing intensity, but immigration is limited by the size and behavior of peripheral stocks. Until fishing intensity on the reefs is reduced by decreased effort or an increase in reef habitat, CPUE for demersal fishes on the reefs off Murrells Inlet will probably remain lower than that on live bottom. To correct this situation, not only off Murrells Inlet but along the whole South Carolina coast, the South Carolina Wildlife Resources Department is actively expanding a number of artificial reefs to meet the needs of reef fishermen. In early 1974, the State added two landing craft to each of the reefs off Murrells Inlet (Fig. 9).

The reefs did not increase surface fishing success and received only about 20 percent of the effort expended for pelagic recreational fishes. Although the total number of angler-hours increased by 121 percent between the summers of 1972 and 1973 the number of angler-hours on the reefs increased by only 13 percent. In 1972 there was no difference in the success for pelagic recreational fishes among habitats, while in 1973 success was highest over coastal habitat. The difference in fishing success over the reefs between summers may have resulted from the presence or absence of prey.

To improve surface fishing success over an artificial reef, we need to incorporate in the reef design features that attract and hold prey. Our knowledge of the appropriate design for

Figure 7.—Estimated number and percentage of angler-hours expended by private boat anglers bottom fishing over artificial (A), live bottom (LB), and coastal (C) habitats off Murrells Inlet, S.C., 1973.

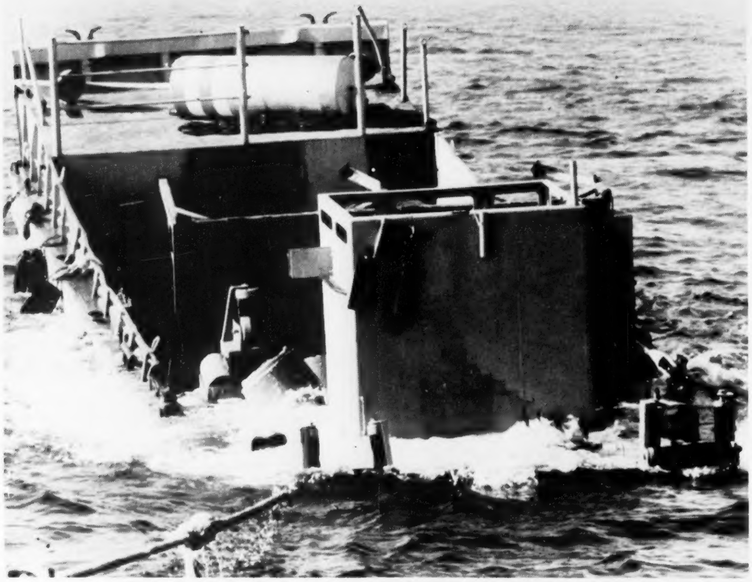


Figure 9.—The sinking of an LCM on Paradise Artificial Reef in the winter of 1973-74 by the South Carolina Wildlife Resources Department. Photo courtesy of South Carolina Wildlife Resources Department.

this purpose is incomplete. Although in general high profile reefs attract more prey and pelagic predators than low profile reefs, a low profile reef off Georgia consistently attracted large numbers of prey and pelagic predators, and a high profile reef off Florida attracted only a few pelagic predators. Placing midwater structures, similar to those discussed by Wickham, et al. (1973), on the reefs may improve surface fishing success by attracting and holding a number of pelagic species in the area for a period of time. Additional studies are needed to determine what structural characteristics influence the reef's attractiveness to pelagic fishes.

Paradise Artificial Reef and Pawleys Island Artificial Reef created recreational reef fisheries in areas where previously none existed. They attracted additional anglers to the areas, resulting in an increase in the gross economic impact of private boat anglers on nearby communities (Buchanan, 1973). Bottom fishermen extensively used the reefs and caught more fish per angler-hour than they did before the reefs were built. Success, however, was not as high as over nearby live bottom. We expect a higher quality bottom fishery to develop once the reefs are enlarged sufficiently to support the fishing pressure they receive. Surface fishing success should also increase once the structural features that attract and hold pelagic fishes become known and can be incorporated with the reefs. As the reefs are expanded and improved, the number and rate at which reef fishes are harvested, the number of angler-hours on the reefs, and the economic growth of nearby communities should increase.

ACKNOWLEDGMENTS

We would like to acknowledge the South Carolina Wildlife Resources Department for its assistance with many phases of our study and several staff members of the Atlantic Estuarine Fisheries Center for suggestions and review of the manuscript.

LITERATURE CITED

Buchanan, C. C. 1972. A comparison of sport fishing statistics from man-made and natural habitats in the New York Bight. Coastal Plains Cent. Mar. Dev. Serv., Semin. Ser. 1:27-37.

________. 1973. Effects of an artificial habitat on the marine sport fishery and economy of Murrells Inlet, South Carolina. Mar. Fish. Rev. 35(9):15-22.

Cupka, D. M. 1972. Aspects of the fishery for and biology of *Centropristis striata* in South Carolina waters. S.C. Dep. Wildl. Resour., Annu. Rep. Proj. 2-138-R-1, 64 p.

Elser, H. J. 1960. A test of an artificial oyster-shell fishing reef, Maryland, 1960. Maryland Dep. Res. Educ. 61-16:1-11.

Rupp, R. S. 1961. Measurement of potential fishing quality. Trans. Am. Fish. Soc. 90:165-169.

Struhsaker, P. 1969. Demersal fish resources: Composition, distribution, and commercial potential of the Continental Shelf stocks off Southeastern United States. U.S. Fish Wildl. Serv., Fish. Ind. Res. 4:261-300.

Turner, C. H., E. E. Ebert, and R. R. Given. 1969. Man-made reef ecology. Calif. Dep. Fish Game, Fish Bull. 146, 221 p.

Wickham, D. A., J. W. Watson, Jr., and L. H. Ogren. 1973. The efficacy of midwater artificial structures for attracting pelagic sport fish. Trans. Am. Fish. Soc 102:563-572.

MFR Paper 1102. From Marine Fisheries Review, *Vol. 36, No. 11, November 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1103

Economics of Gulf of Mexico Industrial and Foodfish Trawlers

ROLF JUHL

ABSTRACT—Presented here are results of a study undertaken in 1973 on economic data of costs and production of the groundfish and foodfish trawling industry in the northern Gulf of Mexico. The need for these data stems from the increased fishing pressure on the northern Gulf groundfish stocks and the apparent interest to utilize these groundfish more effectively. Examples of this are: 1) the use of the incidental catch (which is now discarded) by the shrimp fleet for manufacture of fish meal and petfood, 2) processing sciaenids (especially croaker) into minced fish products. Income projections are shown for optimum vessels of the foodfish and industrial trawl fishery, including operating costs, catch rate and composition, and income projections based on present and past catch data. The data presented can be applied to the operation of vessels used in such fisheries as shrimp trawling or snapper; consequently, they may be of value to vessel owners in determining their own economic projections.

INTRODUCTION

In recent years, the groundfish stocks of the northern Gulf of Mexico have gained considerably in importance as a source of foodfish and as a source for industrial uses. Indications are that because of the increased importance, harvest of these stocks will increase at a faster rate than it has in the past. The decline of the anchoveta fishery in Peru in 1972 and its complete closure in 1973 has greatly contributed to the search for other sources for fish meal. Similarly, the use of small fish, particularly sciaenids (croaker), for processing into specialty foods such as minced fish portions has increased importance of the groundfish stocks of the northern Gulf of Mexico. This will spur the development of the fishing fleets through new construction and through periodic transfer from other fisheries, such as from the shrimp fleet. (At present these fisheries are mutually exclusive.)

Increased pressure on the resources is evident now, as a result of greater shrimping efforts. The higher prices paid for shrimp and the increased operating costs of the larger and more expensive shrimp trawlers have contributed to this situation. The vessels fish longer than in the past and operate in marginal production areas, i.e., in areas where the ratio of shrimp to fish is considerably lower than 1 to 10. The result is a substantial increase over previous years in the incidental fish catch.

Anticipating the need for basic information on the economics of the trawl fishery, we compiled data on the operation of vessels which fish exclusively for industrial fish and shrimp vessels which operate intermittently in taking groundfish for human consumption, hereinafter called foodfish. Information on the latter projects the operation of a "shrimp" vessel engaged in foodfish trawling for an entire year.

Although the economic data presented may not apply specifically to an existing fishery development scheme, they could serve as a guideline in projecting or deciding on a course of action. Reference is made to existing fishery development because it is felt that the eventual goal or outcome in making use of the Gulf groundfish resources is an effective total utilization concept. An example of this is making use of the fish harvested according to their relative economic value—e.g., foodfish, petfood, and fish meal. Owing to the many alternatives (and unknowns), to make predictions relative to the total utilization concept at this time would not be feasible. An example of these alternatives is the potential use of small croaker (*Micropogon undulatus*) for processing into "surimi." Surimi is composed of shredded fish flesh, sugar, and preservatives, and is used in Japan for manufacture into a variety of food products. The best surimi is produced from sciaenid fishes, especially croaker.

It is intended that vessel operating costs and catch projections may assist vessel operators in making their own fishery economics evaluation.

DISCUSSION AND RESULTS

Information on the economics is projected from data gathered from vessel operators, processing plants, Government agencies, and historical records (Roithmayr, 1965). The optimum vessel information is based on annual average current operating costs of the top producers. On this, the following topics are discussed:

1. Vessel characteristics, size, capacity, and type;
2. Optimum level of fishing effort;
3. Catch rate and composition;
4. Economic data of optimum vessels;
5. Income projection of present fleet activities.

Foodfish Fleet

1. Vessel Characteristics—Size, Capacity, Type

The foodfish fleet is composed of approximately 40 vessels; however, these generally operate only part-time. During the summer many engage in shrimping, returning to the food fishery in the fall when the shrimp catch declines.

The vessels are typical double-rigged shrimp trawlers, ranging in size from 65 to 85 feet LOA with an average of 78 feet. Their carrying capacity is from 52 to 100 tons, averaging 80. Horsepower ranges from 240 to 425, averaging 350. Net sizes are from 50 to 70 feet, averaging 62. Trawl door dimensions vary between 9 feet × 40 inches and 12 feet × 44 inches, averaging 10 feet × 44 inches. The optimum vessel is considered to

Rolf Juhl is a member of the staff of the Southeast Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Drawer 1207, Pascagoula, MS 39567. Contribution No. 250.

be 80 feet long, with a capacity of 80 tons, has a 350 horsepower engine, and uses two 65 foot nets and 10 foot × 44 inch doors (Gutherz, et al., in press). In this paper the term optimum refers to the economic achievement of an above-average fishing vessel. At least one-fourth of the fishing vessels of the industrial and foodfish fleets fall in this category.

2. Level of Fishing Effort

Currently, the foodfish vessels fish an average of 13 hours per day, daytime only. Normally, four tows are made per day depending on the catch rates.

Under the present fishing strategy, an optimum foodfish vessel could make 33 trips per year without reverting to shrimping. The average trip is 6½ days; 5 days are spent fishing and 1½ days running. The trips may be as short as 3 days or as long as 12. Based on 33 trips per year, 5 days per trip, and 13 hours per day fishing, the annual total is 2,145 hours of fishing effort.

3. Catch Rate and Composition

The estimated average catch, composition, and rate per hour were calculated from records supplied by three top ranking (highliners) foodfish vessels covering several months' fishing activity during 1970-72. These follow:

Average Catch Rates

Marketable foodfish (60%)		
Croaker	328 lb/hr	
Other finfish	22½ lb/hr	
Shrimp (heads on)	7½ lb/hr	
SUBTOTAL		358 lb/hr
Discards (40%)		
Croaker* (Surimi & smaller)	122 lb/hr	
Trash	121 lb/hr	
SUBTOTAL		243 lb/hr
TOTAL		601 lb/hr

*Surimi size croaker range from 3 to 7 oz each

Projecting the figures for an entire year's operation, the following totals are derived:

Projected annual production

Marketable foodfish		
Croaker	703,560 lb	
Other finfish	48,262 lb	
Shrimp (heads on)	16,088 lb	
SUBTOTAL		767,910 lb
Discards		
Croaker (Surimi & smaller)	261,690 lb	
Trash	259,545 lb	
SUBTOTAL		521,235 lb
TOTAL		1,289, 145 lb

From the above figures, 20% of the total catch is composed of surimi size and smaller croakers and 20% sharks, skates, rays, etc., which are now discarded.

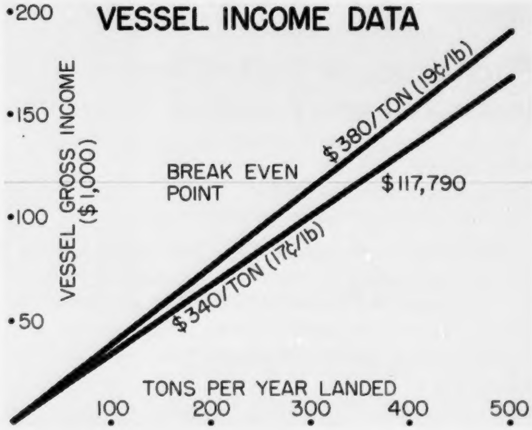


Figure 1.—Data based on optimum foodfish vessel economics: 33 trips per year, 2,150 fishing hours and fixed owner's expense. Note that the chart applies only to the gross income and expense of the vessel, not the crew.

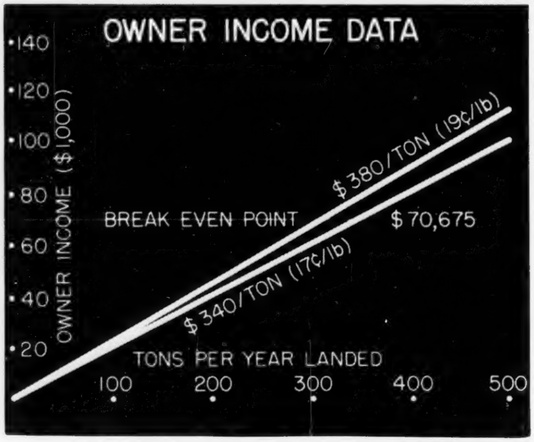


Figure 2.—Data based on optimum foodfish vessel economics: Operating costs of 33 trips (3,760 hours) per year as shown in text.

4. Economic Data of Optimum Vessel

The operating costs per year are based on 33 trips, the equivalent of 3,760 hours of which 5 days (2,145 hours) per trip are spent fishing and 1½ days (1,615 hours) running.

Annual operating expenses (rounded)

1. Fuel, 3,760 hours at 25 gal/hr at 32¢/gal	$30,080
2. Lubricants, 260 gal at $1.25/gal	325
3. Galley supplies $5.00/day/man (3 men)	3,215
4. Repair & maintenance (haulout, etc.)	1,000
5. Spare parts & supplies, engine (filters, etc.)	300
6. Engine & Equipment repair & maintenance	2,500
7. Fishing gear repair and replacement	
(a) Nets—2½ nets per year	3,500
(b) Doors—2 sets per year	800
(c) Twine, webbing, chaffing gear	400
(d) Cable—400 fms every 2 yr at 24¢/ft	290
(e) Blocks, lines	300
8. Deck supplies and material	350
9. Administrative expenses	600
10. Repayment of principal on 75% of $150,000 or $112,500 for 10 yr	11,250
11. Interest payment, 10 yr at 8-½%	4,775
12. Amortization of $37,500 (10%)	3,750
13. Insurance, hull, and P&I (3-½% & $1,500)	5,700
14. Ice, 40 tons per trip at $9.85/ton	13,000
15. Contingency	3,000
TOTAL	$82,135

NOTE: Of the above total, Items 3, 7, and 14 are deducted from the crew's share on the following basis:

3. Galley supplies (total paid by crew)	$ 3,215
7a. Nets (Cost of labor paid by crew, ½ of total)	1,750
14. Ice (Crew pays ½ the cost)	6,500
	$11,460

5. Income Projection of Present Fleet Activities

This projection reflects the estimated annual operation of an optimum foodfish vessel calculated from the catch and cost data shown previously. Prices shown are ex-vessel, current as of May 1974.

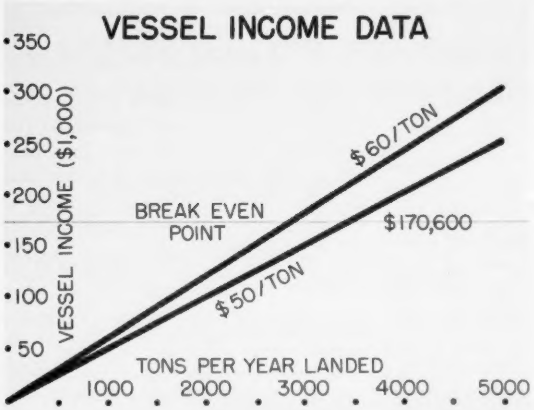


Figure 3.—Data based on optimum industrial fish trawler economics: 40 trips per year, 2,600 fishing hours and fixed owner's expense.

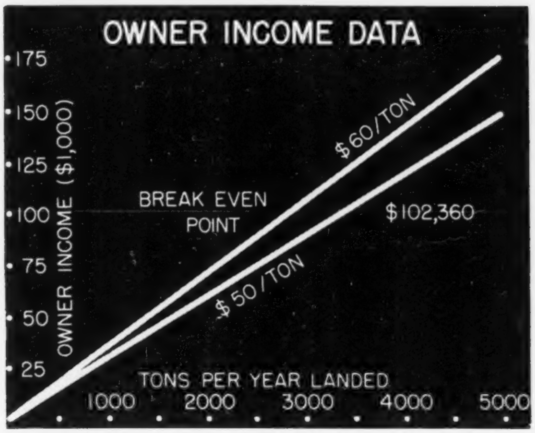


Figure 4.—Data based on optimum industrial fish trawler economics: 40 trips per year, 2,600 fishing hours, owner's expenses, and income projection.

Projected income (based on actual production)

Marketable foodfish (totals rounded)		
Croaker*	784,000 lb	
Large	25% at 22¢/lb	$ 43,000
Medium	40% at 18¢/lb	56,500
Small	35% at 7¢/lb	19,200
*Includes 30% or 80,470 lb of small croaker that used to be discarded but is now marketable.		
Other finfish	48,000 lb at 20¢	9,600
Shrimp	16,000 lb at 85¢/lb (21-25 count heads on)	13,950
TOTAL INCOME		$142,250
Normal split:	40% for crew	$ 56,900
	60% for owner	$ 85,350
Total annual expenses		$ 82,135
Less crew's expenses		$ 11,460
Owner's expenses		$ 70,675
Crew's share (total crew: 3 men)		$ 56,900
Less deductions (expenses)		$ 11,460
Net crew's income		$ 45,440
Owner's share (or boat share)		$ 85,350
Less expenses		$ 70,675
Net owner's income (or boat share)		$ 14,675

Applying the cost and production figures to vessel operation for 1 year, graphs can be prepared to show income projections at various levels of production, prices paid for fish, hours fished, etc. An owner can use the figures applicable to his vessel to determine levels of income under varying conditions. Figures 1 and 2 show graphs on the income and catch figures of an optimum foodfish vessel.

Industrial Fish Fleet

1. Vessel Characteristics, Size, Capacity, Type

The industrial fish fleet consists of only 15 vessels; however, they are larger than the foodfish counterparts and fish exclusively for industrial type fish.

The overall length and carrying capacity varies from 80 feet to 121 feet and 72 to 300 tons, averaging 94 feet and 138 tons.

Main engine horsepower ranges from 350 to 1,000, averaging 546. Net size (corkline length) varies from 52 feet to 100 feet; the mean is 84 feet. Trawl doors range from 10 feet × 50 inches to 15 feet × 72 inches, averaging 12 feet × 60 inches. In this fleet, the optimum vessel characteristics are estimated to be 90 feet LOA, 150-ton capacity, 600 horsepower, 82 foot net and 12 foot × 60 inch doors.

2. Level of Fishing Effort

The industrial fish vessels engage in fishing activities an average of 14½ hours per 24-hour day. Generally, four to five tows are made per day, depending on the catch rate. From information gathered from the existing fleet, an optimum vessel makes at least 40 trips per year. The average duration of each trip is 6 days, 4½ days fishing and 1½ days running to and from port. Based on these figures, the annual total fishing effort would be 2,600 hr. The length of the trips ranges from 2 days to a maximum of 8 days, not including broken trips caused by eventualities.

3. Catch Rate and Composition

Applying catch data from production records covering several years (1968-72) of four industrial vessels, the production potential per hour and partial catch composition for an optimum vessel are projected as follows:

Fish for industrial processing	3,120 lb
Foodfish (2%)	62 lb
Shrimp	8 lb
TOTAL	3,190 lb

NOTE: Foodfish and shrimp are removed by plant personnel and vessel crew as the catch is conveyed in for processing

Projecting these figures for a full year's operation will produce the following totals:

Fish for industrial use 3,120 × 2,600 hr	8,112,000 lb
Foodfish (2%)	162,200 lb
Shrimp 8 × 2,600 hr	20,800 lb
TOTAL	8,294,000 lb

4. Economic Data of Optimum Vessel

Operating costs per year based on 40 trips, the equivalent of 4,040 hrs (2,600 hrs fishing and 1,440 hrs running) in which 4½ days per trip are spent fishing and 1½ days running:

Annual operating expenses

1. Fuel, 4,040 hr at 35 gal/hr at 32¢/gal	$ 45,248
2. Lubricants, 550 gal at $1.25/gal	688
3. Galley supplies, $5.50/day/man (3-man crew)	3,960

4.	Repair & maintenance (haulout, etc.)	3,500
5.	Spare parts & supplies, engine (filters, etc.)	400
6.	Refrigeration & power plant or drive maintenance	350
7.	Fishing gear repair & replacement	
	(a) Nets—2½ nets per year	4,500
	(b) Doors—2 sets per year	1,200
	(c) Twine, webbing, chaffing gear, etc.	350
	(d) Cable 400 fm every 2 yr at 37.5¢/ft	450
	(e) Blocks, lines	350
8.	Deck working supplies & materials	275
9.	Administrative expenses	600
10.	Repayment of principal on 75% or $250,000 for 10 yr ($187,500)	18,750
11.	Interest payment, 10 yr at 8-½%	7,950
12.	Amortization of $62,500	6,250
13.	Insurance, hull, & P & I (3½% & $1,500)	8,500
14.	Contingency	3,000
	TOTAL	$106,321

NOTE: Item 3, Galley supplies, is deducted from the crew's share. The owner pays the balance.

	$106,321
Less Item 3	3,960
Owner's expense	$102,361

5. Income Projection, Present Fleet Activities

The following is a projected estimate of the economics of an industrial fishing vessel operation for 1 year. The costs and production figures are taken from the foregoing text. Fish prices are current as of May 1974.

Projected income	
Industrial fish production, 8,112,000 lb = 4,056 tons at $50/ton	$202,800
Foodfish 162,200 lb at 8¢/lb	12,976
Shrimp (heads on) 20,800 lb at 50¢/lb*	10,400

*Owing to inferior quality of shrimp landed by industrial trawlers the selling price is less than for foodfish trawler caught shrimp.

TOTAL INCOME	$226,176
Breakdown of income & expenses	
Income from sale of industrial fish	$202,800
Normal split:	
40% for crew	$ 81,120
60% for owner	$121,680
Crew's share (Total crew: 3 men)	$ 81,120
Less deductions	$ 3,960
SUBTOTAL	$ 77,160
Plus income foodfish	$ 12,976
Plus income shrimp	$ 10,400
NET INCOME OF CREW	$100,536
Owner's share	$121,680
Less expenses	$102,361
NET INCOME OF OWNER	$ 19,319

Figures 3 and 4 show the cost and production figures as applied to the operation of an optimum industrial fish trawler. Here again it is intended to show how figures can be used to determine income projections. These can be varied to apply to a specific vessel operation.

LITERATURE CITED

Gutherz, E. J., G. M. Russell, A. F. Serra, and B. A. Rohr. (In press). Synopsis of the northern Gulf of Mexico industrial and foodfish industry.

Roithmayr, C. M. 1965. Industrial bottomfish fishery of the northern Gulf of Mexico, 1959-63. U. S. Fish Wildl. Serv., Spec. Sci. Rep. Fish. 518, 23 p.

MFR Paper 1103. From Marine Fisheries Review, *Vol. 36, No. 11, November 1974. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

ICNAF Increases U.S. Fish Quota 16,600 MT; Names NOAA Official Vice Chairman

United States fishermen were granted a quota increase of 16,600 metric tons for 1975 at a summer meeting of the International Commission for the Northwest Atlantic Fisheries (ICNAF) in Halifax, Nova Scotia. ICNAF regulates certain fisheries in international waters off the northeast coast of the United States and Canada.

The primary purpose of the meeting was to allocate a 1975 overall catch quota and seek management arrangements for fish stocks for the 17 member nations, all of whom were represented except Romania. The overall quota applies to species fished in the southern portion of the Convention Area off the coast of New England and the Middle Atlantic States.

Although the overall quota was reduced from 924,000 metric tons in 1974 to 850,000 metric tons for 1975, the 1975 U.S. share of the total quota increased from 20 to 25 percent. With the exception of a modest increase for Canada, quotas of all other nations were reduced in order to provide the total required reduction of approximately 74,000 metric tons as agreed at an earlier meeting of the international group. For 1976, nations have agreed to set the overall quota at a level consistent with maintaining the maximum sustainable yield.

Other actions taken by the Commission included the election of David H. Wallace, Commissioner for the United States to ICNAF, to be Vice Chairman of the Commission, and an invitation to hold its next annual meeting in Edinburgh, Scotland, beginning 10 June 1975. Mr. Wallace is the Associate Administrator for Marine Resources of NOAA.

Scientific advisers for ICNAF met prior to the full meeting and provided the authoritative advice on which quotas were allocated. U.S. scientific advisers come from the National Oceanic and Atmospheric Administration's National Marine Fisheries Service.

Because of the serious condition of flounder stocks in the southern New England area, the United States proposed that additional protective measures be considered in conjunction with the recommended zero quota designed to improve further the effectiveness of existing gear regulations in this area. The aim is to reduce foreign incidental catches of yellowtail flounder and other groundfish stocks important to U.S. fishermen. Partial approval of the U.S. plan was obtained: an area off southern New England, where bottom trawling by large vessels is prohibited, was extended southward to waters off New Jersey, and additional vessels will be phased out of bottom trawling in the critical area by the end of 1976.

The United States maintained that additional progress is required in this and related areas to provide sufficient additional protection for groundfish species such as yellowtail flounder. Consequently, it was agreed that a special meeting of the concerned member governments would be held in the fall of 1974 to resolve the remaining problems and that proposals adopted at that time would be forwarded for telegraphic vote by all Commission members.

Over 200 delegates attended the Halifax meeting representing Bulgaria, Canada, Denmark, France, Federal Republic of Germany, German Democratic Republic (attending for the first time as a full member), Iceland, Italy, Japan, Norway, Poland, Portugal, Spain, Union of Soviet Socialist Republics, United Kingdom, and the United States. Observers from Cuba attended and indicated Cuba's desire to join the Commission. Representatives of a number of other international fisheries organizations also attended.

NOAA Chief Sees Significant Progress in International Whale Preservation Measures

Although the United States did not achieve its goal of a 10-year moratorium on all commercial whaling, "significant progress" has been made in many aspects of international whale conservation, according to Dr. Robert M. White, U.S. Commissioner of the International Whaling Commission, and Administrator of the Commerce Department's National Oceanic and Atmospheric Administration.

Progress was made in four major areas during last summer's 26th Session of the IWC in London, England, Dr. White noted. They are:

1. A selective moratorium will apply to any stock of whales that falls below optimum population levels.
2. World-wide quotas for whale species of most concern have been greatly reduced.
3. Whale stocks will be managed by ocean areas rather than oceans as a whole.
4. In establishing optimum stock levels, factors other than simple number of whales will be considered—factors that encompass the health of the total marine ecosystem, and that will lead to establishment of more conservative quota levels.

"Adoption of the principle of a selective moratorium represents a major change in the outlook for the preservation of the world's whales," said Dr. White. "Imposition of such a moratorium—suggested by the Australians as an amendment to the U.S. proposal for a 10-year moratorium on all whaling—will ensure the most rapid possible restoration of depleted whale stocks." The Commerce Department official noted that the action makes possible a moratorium for certain species, such as the fin whale, for longer than 10 years.

The world-wide quotas established by the Commission provide significant reductions in the allowed catch of several species. In the case of the fin whale, last year's quota has been reduced by 35 percent, from 2,000 to 1,300, with an anticipated reduction to zero for the 1975-76 whaling season. The quota for the sei whale has been reduced 20 percent, from 7,500

to 6,000. The sperm whale quota was maintained at last year's level of 23,000.

Only in the case of minke whales has the quota increased, from 5,000 to 7,000, on the assurance of scientists that this level will not seriously affect stocks of this small whale, which has only recently begun to be harvested.

The total number of whales that will be allowed by the quotas approved by the IWC for the next year total 37,300.

The agreement that all whale stocks will be managed by ocean areas, rather than for the oceans as a whole, will make possible much improved conservation and management by individual whale stocks. Quotas are established for each ocean area, rather than for the oceans as a whole. This means, for example, that if a whaling vessel catches its quota for an area, it may not catch additional whales in that area but must move to another. This provision eliminates the danger of seriously depleting individual stocks within an area, as has happened in the past.

The fourth area of major progress involves new methods for determining optimum population levels, and provides that factors such as the weight of the animals, the interaction among various species of whales and between whales and other living things, be considered.

"The progress achieved at this Commission meeting, while falling short of the U.S. objectives, is gratifying and is due to the recognition by member countries of the increasing need for improved conservation measures," Dr. White said. "A critical element in the changing attitude of the International Whaling Commission has been the advocacy of strong whale conservation measures by nongovernment environmental organizations both in the U.S. and in other countries.

"The United States remains concerned about many features of international whale management and conservation. Catch Per Unit of Effort of critical species of whales continues to fall. This is a warning signal that whaling stocks may be in less healthy shape than some data portray."

He also stated that in the U.S. view quotas are still being set too high, particularly in view of the uncertainties in the base data and the risk of long-term or irreversible losses of the resource and the possibility that local stocks may be overfished.

"Finally," he noted, "the question of the humaneness of whale killing methods requires further examination."

In other actions at the meeting, the Commission decided to strengthen the Secretariat and its research activities. To that end it voted a budget increase from $16,800 to $86,400. There was agreement by all member countries for the first time to consider changes in the International Convention for the Regulation of Whaling and a working party was established to undertake a thorough consideration of possible changes.

Scientific Attention Is on Bluefin Tuna

Have populations of the spectacular bluefin tuna diminished to such a low point in the Atlantic as to threaten the continued use of the species as an important fisheries resource?

Answers to that and other questions about the giant fish are being sought in an expanded scientific investigation of bluefin tuna stocks in the Atlantic by the National Oceanic and Atmospheric Administration. The program has been placed under the direction of the Southeast Fisheries Center (Miami, Fla.) of NOAA's National Marine Fisheries Service.

The Commerce Department agency seeks to bring into close cooperation all states, organizations, and persons interested in the conservation of the bluefin tuna while assessing its status after years of heavy fishing by sport and commercial fishermen on both sides of the Atlantic. NMFS scientists are shaping their effort to culminate in the rapid establishment of a national bluefin management and conservation policy formulated to offset any declines in bluefin populations and revitalize the stocks. Various states are expected to play a significant part in the management program.

Contributory research is carried out at the NMFS Southwest Fisheries Center, La Jolla, Calif., and at the Northeast Fisheries Center, Woods Hole, Mass. Advising and assisting to varying degrees in the stepped-up tuna investigation (the NMFS has been engaged in various kinds of tuna research for many years) are recreational and commercial tuna fishermen, state organizations, conservation agencies, and international advisory groups.

Sportfishermen traditionally begin looking for the giant bluefins around the Bahamas and the Florida Straits in May. As spring and summer wear on, the big fish become increasingly abundant off the eastern shore of the United States, and sport anglers and fishing clubs sponsor tournaments in various locations, beginning at Cat Cay in the Bahamas. Many of the tournaments date back to the 1930's, and some of these have been cancelled for the first time this year, in a positive response to conservation appeals by national gamefish organizations such as the International Game Fish Association (IGFA). Many sport groups are proposing tag and release tournaments both for expansion of data collecting and to try to save the fish. The bluefin season generally ends around October off the Canadian coast with a major tournament at Nova Scotia and Prince Edward Island, where anglers often catch tunas of enormous size. Last year, for instance, a record 1,120-pound bluefin was landed off Prince Edward Island.

Commercial bluefin catches have fluctuated significantly during the past several years: Smaller bluefin are caught commercially off the mid-Atlantic U.S. coast; the once-abundant European commercial catch is now greatly reduced; and some Asian nations, particularly Japan, value bluefin meat above all other tunas and now must import much of the desired supply at excessive cost.

Authoritative opinion as to the present status of the bluefin tuna stocks is somewhat divided. Some observers believe that populations of the giant species have been decimated by past fishing pressure; others suggest that the relatively fewer bluefin seen in recent years may be the result of a combination of natural population fluctuations and possible departures of the fish from customary migratory routes as well as fishing pressures. Differences of opinion can be traced to inexact knowledge of what constitutes a

naturally abundant bluefin population compared to a depleted one, migration variations of the extremely mobile species, biological factors, and effects of fishing pressure on the stocks.

Concern for the stocks is aggravated by recent catch figures: In 1973, the U.S. commercial catch of bluefin in the Atlantic dropped by one-third, from 1,490 metric tons in 1972; on the other hand, sport fishermen caught a record 659 heavyweight bluefins (about 250 tons of fish between 300 and 1,200 pounds) from 72 vessels (also a record) at a popular fishing tournament held in the fall of 1973 in northwest Atlantic waters. Some marine biologists have expressed concern over a possible shortage of medium-sized fish—the future breeders — noted in recent catches. They say that for some time most of the bluefin tuna caught have fallen into either the immature class (under 50 pounds) or the giant class (over 300 pounds).

The broad scientific exploration underway at NMFS laboratories seeks answers to many questions. A sampling might include:

1. What is the relation—or difference—between stocks of bluefin in the eastern and western Atlantic? How much migration occurs over what distances, and in what direction?

2. How old are the giant bluefins boated in the northwest Atlantic?

3. When, where, and under what circumstances do bluefin tuna spawn? What happens to the larval fish and what factors affect survival and growth? Are the medium-sized fish missing from today's catches at significant levels?

4. How soon can valid assessments of total stocks be reached through population dynamics studies?

Among the many tools to be used to assemble the needed data base are: expanded tuna-tagging programs; increased information on catch and effort from non-traditional sources such as the Japanese longline fleet; close working relationships with sport fishing clubs and organizations such as IGFA, Sport Fishing Institute, the National Coalition for Marine Conservation and others; logbooks to record sport catch data in many ports along the eastern seaboard and in the Caribbean; aerial spotting surveys of bluefin schools; a greatly expanded exchange of information between American and European marine scientists; and continuing involvement with the International Commission for the Conservation of Atlantic Tuna to coordinate studies leading to rational international management of Atlantic bluefin tuna.

Commerce Department Denies Commercial Marine Mammal Kill Permits for Second Year

For the second successive year the Commerce Department has denied all requests for permits to kill marine mammals for commercial purposes, according to a recent report by Secretary Frederick B. Dent. The Secretary's second annual report to the Congress and the U.S. public on actions taken by the National Oceanic and Atmospheric Administration with reference to marine mammals was delivered, as required, by 21 June 1974.

The extensive document (181 pages), submitted to the Senate and the House of Representatives, among other things delineates the reasons for, and the character of, several procedural or regulatory changes either proposed or made in the administration of the Marine Mammal Protection Act of 1972.

The Secretary's report also describes the circumstances surrounding the handling of a number of 92 applications so far received by NOAA's National Marine Fisheries Service for permission to capture or otherwise acquire some 10,000 marine mammals, all to be used for scientific research or public display. Most of twenty approved applications involved the capture and release of almost 9,000 of the ocean-dwelling animals for scientific research; the next largest number of permits was granted to persons and organizations wishing to retain custody of animals for either scientific research or public display. Other applications have been denied, withdrawn, or referred to appropriate States for action; 65 of the 92 applications to take or use marine mammals in various ways awaited disposition as of the end of April.

The Act, which took effect in December 1972, is administered and enforced by NOAA's National Marine Fisheries Service in matters related to porpoises, whales, seals, and sea lions. Other marine mammals come under the jurisdiction of the Department of the Interior. The Act established, with some exceptions, a moratorium on the taking or importation of marine mammals and on the importation of marine mammal products.

The Act stipulates that a series of legal, scientific, and technological steps be taken by the Commerce and Interior Departments in a sustained effort to maintain—and if necessary rebuild—populations of marine mammals. It also requires that an annual accounting be made of the stewardship of the Act by the responsible Federal agencies.

The current report, in three parts, covers the period June 1973 through April 1974. The first part, "Actions Taken to Assure the Well-Being of Marine Mammals," describes the details surrounding: economic hardship exemptions; public display and scientific research permits; applications for waiver of the moratorium; research and development of fishing gear designed to prevent harm to porpoises associated with tuna fishing; research of fur seals on the Pribilof Islands in the Bering Sea; legal enforcement of the tenets of the Act; and international programs related to marine mammals.

The second part of the report, "Current Status of the Stocks of Marine Mammals," contains lists of marine species with which the NMFS is concerned, along with scientific information about those species compiled by many marine biologists. It also lists and summarizes existing marine mammal laws and regulations.

The third section contains appendices germane to recent marine mammal actions, regulations, and notices.

The text of the Secretary's report appeared in the *Federal Register* dated 24 June 1974 (39F.R.23895).

Canada Reorganizes Fisheries Operations

New organizational arrangements which are a part of a continuing program to strengthen the capability and reponsiveness of the Fisheries and Marine Service of Environment Canada have been announced by Robert F. Shaw, Deputy Minister of Environment.

Responsiveness to regional and provincial needs within the framework of national policies will be achieved by greater delegation of management responsibilities to the regional executives of the Service. In Ottawa, administration of line operations will come under two assistant deputy ministers reporting to Ken Lucas, Senior Assistant Deputy Minister, Fisheries and Marine Service. At headquarters, the Fisheries and Marine Service has consolidated what were previously six line organizations into two major groupings: (1) Fisheries Management and (2) Ocean and Aquatic Affairs. Among activities which will be brought together within these two groups are the former Fisheries Operations Directorate, the research functions formerly managed directly by the Fisheries Research Board, and the Marine Sciences Directorate.

Responsibilities consolidated under the new ADM, Fisheries Management, include resource management and conservation; enforcement of fisheries regulations including operation of a major ocean patrol fleet and surveillance aircraft; industrial development and fish inspection; marketing and promotion; biological and technical research on fish and other aquatic flora and fauna; fishing vessel insurance and vessel construction subsidy administration; management of small craft harbours across Canada; promotion and management of recreational fisheries; and administration of international and federal-provincial fisheries agreements.

Regional fisheries management will be consolidated under five regional directors-general located at Vancouver, Winnipeg, Quebec City, Halifax, and St. John's.

The ADM, Ocean and Aquatic Affairs, will be responsible for the consolidated physical and chemical oceanographic research; biological research related to the quality of the marine environment; environmental assessments of activities affecting freshwater and marine life; marine geophysical mapping; operating of a fleet of research and survey vessels; hydrographic surveying; tide and water levels measurement and production of navigational, bathymetric and other charts of Canadian coastal and inland waters.

Reporting directly to the ADM, Ocean and Aquatic Affairs, will be three directors-general located at Victoria, B.C., Dartmouth, N.S., and Burlington, Ont. These officers will direct consolidated ocean and aquatic programs in a similar manner to and in cooperation with their fisheries management counterparts.

Appointed to the position of Assistant Deputy Minister, Fisheries Management, is David J. McEachran, 39, who since 1972 has been Acting Deputy Minister of the Alberta Department of Industry and Commerce under the Federal Government's Executive Interchange Program.

Named Assistant Deputy Minister, Ocean and Aquatic Affairs, is Dr. A.E. Collin, 44, of Ottawa, formerly Director-General of the Marine Sciences Directorate and Acting Director-General for Fisheries Research and Development.

Appointed Regional Directors-General for Fisheries Management were: H.D. Johnston, 40, Maritimes Region, Fisheries Regional Director at Halifax since July, 1973; L.J. Cowley, 38, Newfoundland Region, Fisheries Regional Director at St. John's since August, 1972; Jean Fréchet, 49, Quebec Region, has been closely associated with federal-provincial fisheries development projects in the province of Quebec for many years.

Appointed Regional Directors-General for Ocean and Aquatic Affairs were: Dr. R.W. Stewart, 50, Pacific Region, who has been Director, Pacific Region, Marine Sciences Directorate, at Victoria, since 1970; and Dr. W.L. Ford, 60, Atlantic Region, who has been Director of the Atlantic Oceanographic Laboratory, Dartmouth, N.S. since 1965. Staffing is presently under way for the remaining director-general positions.

Referring to the present organization of the Department of the Environment, Mr. Shaw noted that freshwater quality and quantity, river basin studies and research hydrology, with the exception of studies related to fish and other aquatic life, would remain with the Inland Waters Directorate of the Environmental Management Service, while the drafting and implementation of environmental regulations would stay with the Environmental Protection Service.

Japan Tells Tuna Purse Seiner Status

Five years have elapsed since the Japanese began focusing attention on U.S.-type purse seine fishing for tuna. At present, the number of independently operated tuna seiners in Japan totals 11, ranging in size from 210 to 1,000 gross tons. The United States has a purse seine fleet of around 130 vessels. Some Japanese say that Japan will need at least 30 seiners to establish a tuna seine fishery. A search for the most economic size of seiners continues in Japan, but recent purse seiner construction trends indicate that 500-ton-class vessels, which comprise over half of the present fleet, are preferred by the Japanese.

The *Nippon Maru* (999 gross tons and about 800 tons carrying capacity), the largest seiner in Japan, began operations in 1971 with a crew of seven Americans and twelve Japanese, but she is now manned only by fifteen Japanese members. In 1971, that vessel, which operated in the eastern Pacific and eastern Atlantic, caught 760 metric tons of fish in 56 sets during four and one-half months of operation. The catch in the second year was 2,100 tons taken in 208 sets during

Japanese distant-water tuna purse seiners.

Name of vessel	Size (Gross tons)	Owners
Nippon Maru	999.99	Kaigai Makiami Gyogyo K.K. (Overseas Purse Seine Fishing Company)
Hayabusa Maru	499.99	Taiyo Gyogyo
Hayabusa Maru No. 2	499.96	Taiyo Gyogyo
Wakaba Maru	499.37	Kyokuyo
Hakuryu Maru No. 55	499.06	Kyokuyo
Fukuichi Maru	499.57	Fukuichi Gyogyo
Gempuku Maru No. 82	499	Toyo Gyogyo
Hayabusa Maru No. 3	275.84	Taiyo Gyogyo
Nissho Maru	252.93	Fukuichi Gyogyo
Taikei Maru No. 23	210.20	Ogata Kimpei
Tokiwa Maru No. 58	357.95	Okura Gyogyo

nine months of fishing in the same oceans, and in the third year 1,700 tons were taken in ten months. This year, the *Nippon Maru*, which entered the eastern Pacific yellowfin regulatory area on January 10, reported a catch of 350 tons to February 28. In the South Pacific, 5-6 seiners were reported fishing in late April. The outlook for profitable operations in that region appears hopeful.

Japanese tuna seining in the eastern Atlantic was launched by Nichiro Fisheries in 1964 with five vessels consisting of a 1,600-ton mothership and two pair-boat seiners (pairs of 145-ton and 85-ton seiners). Nichiro continued operations unprofitably for the next nine years and terminated the venture in 1972 because of the deterioration of the vessels.

Sources: *Minato Shimbun, Suisan Shuho,* and *Shin Suisan Shimbun.*

JAPANESE UNIVERSITY TO BUILD LARGE U.S.-TYPE TUNA PURSE SEINER

The Department of Fisheries of Nagasaki University is building a U.S.-type tuna purse seiner of 1,000-gross-ton size. It will be the second 1,000-ton tuna seiner in Japan and probably the world's first U.S.-type seiner to be used as a training vessel by an educational institution. Construction completion is set for early April 1975.

To be built at an estimated cost of 1,400-1,500 million yen (US$5-5.4 million at 280 yen = $1), the seiner will have the following specifications: overall length, 62 meters (203 feet); width, 11.5 meters (38 feet); depth, 5.2 meters (17 feet); main propulsion, 2,800-hp diesel engine; maximum speed, 15 knots; cruising speed, 14 knots. It will carry four instructors and 50 students. Upon completion, the vessel will be sent on a training cruise to the Coral Sea and the waters north of New Guinea in the southwest Pacific.

Publications

Recent NMFS Scientific Publications

Circular 330, Volume 8. Love, Cuthbert M. (editor). **"EASTROPAC Atlas."** March 1974, vii + 184 figures. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

This atlas contains charts depicting the distribution of physical, chemical, and biological oceanographic properties and associated meteorological properties observed during EASTROPAC. EASTROPAC was an international cooperative investigation of the eastern tropical Pacific Ocean (20°N. to 20°S., and from the west coasts of the American continents to 119°W.) which was intended to provide data necessary for a more effective use of the marine resources of the area, especially tropical tunas, and also to increase knowledge of the ocean circulation, air-sea interaction, and ecology. The Bureau of Commercial Fisheries (now National Marine Fisheries Service) was the coordinating agency. The field work, from February 1967 through March 1968, was divided into seven 2-month cruise periods. During each cruise period one or more ships were operating in the study area.

On completion of the field work the data seemed too numerous for a classical data report. Instead, it was decided to produce an 11-volume atlas of the results, with 5 volumes containing physical oceanographic and meteorological data from the principal participating ships, 5 volumes containing biological and nutrient chemistry data from the same ships, and 1 volume containing all data from Latin American cooperating ships and ships of opportunity. Extensive use was made of a computer and automatic plotter in preparation of the atlas charts. Methods used to collect and process the data upon which the atlas is based are described in detail by the contributors of the following categories of charts: temperature, salinity, and derived quantities; thickness of the upper mixed layer; dissolved oxygen; meteorology; nutrient chemistry; phytoplankton standing stocks and production; zooplankton and fish larvae; micronekton; birds, fish schools, and marine mammals.

NOAA Technical Report NMFS CIRC-388. Shaw, William N. (editor) **"Proceedings of the first U.S.-Japan meeting on aquaculture at Tokyo, Japan, October 18-19, 1971."** February 1974. 133p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. (No abstract)

Data Report 84. Saloman, Carl H. **"Hydrographic and meteorological observations from Tampa Bay and adjacent waters—1971."** 554 p. (9 microfiche). For sale by U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22131.

ABSTRACT

Hydrographic data include water temperature, salinity, total phosphorus, total Kjeldahl nitrogen, pH, dissolved oxygen, turbidity, water transparency, chlorophyll *a*, *b*, and *c*, astacin and nonastacin carotenoids, and primary productivity based on chlorophyll *a* extraction. Hourly observations on air and water temperature, rainfall, wind velocity and direction, tidal height, barometric pressure, and daily recordings of solar radiation are also included. Methods of collecting and analyzing samples are described. Tables summarizing data collected from 30 permanent stations according to month and area, tables summarizing data for each individual station of the 30 permanent sites for 1966-71, and tables summarizing the mean, range, and number of observations of samples taken twice daily at the Laboratory dock are included.

In Brief . . . .

Squid, Nautical Charts, and Pair Seining

. . . . **Squid could return a tidy profit to American fishermen** if exported to Europe, according to a Massachusetts Institute of Technology Sea Grant Program study. U.S. consumers reportedly have a "poor attitude" toward squid which is particularly popular in Mediterranean areas and the Orient . . . .

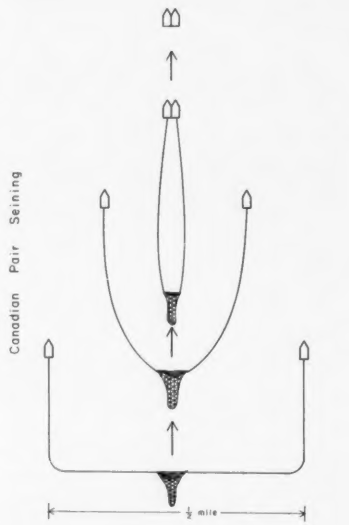
. . . .**Expansion of Sea Grant activities** to include other nations is being studied at the University of Rhode Island's International Center for Marine Resource Development. Plans for a conference on the idea are also in the works, reports *Sea Grant 70's* ....

. . . .**Petroleum may be entering the marine food chain via a tropical coral mucus** eaten by certain reef fish, according to a Scripps Institution of Oceanography scientist. The mucus is rich in triglyceride and wax ester—the latter a major energy source for most temperate and polar ocean fish. Wax globules can absorb spilled oil which could then be eaten by the fish . . . .

. . . .**Fish "coughing" may help indicate water pollution levels** according to Environmental Protection Agency aquatic biologists at the National Water quality laboratory, Duluth, Minn. By comparing "coughs" per minute (normal gill-cleaning process), researchers hope to learn how to keep tabs on industrial wastes in lakes and streams. Short-term effects of 10 heavy metals and pesticides are being studied . . . .

. . . . **J. W. Hudson and W. Don Welch have recently been appointed to the Marine Resources Advisory Committee** of the Coastal Plains Regional Commission and to the Board of Trustees of the Coastal Plains Marine Center, by South Carolina Gov. John C. West, according to *The Marine Newsletter*. Hudson is chairman of the South Carolina Wildlife and Marine Resources Commission and Welch is Executive Director of the South Carolina State Ports Authority. . . .

. . . . **Experimental Canadian pair seining**[1] by two Pt. Judith, R.I. lobstermen hauled in nearly 1.5 tons of fish per day, including codfish, flounder, and whiting, for a satisfactory income, University of Rhode Island fisheries specialists report. The two vessels laid out thousands of feet of steel and fabric line along the ocean floor (see figure below) and line movement frightened fish toward the oncoming bottom trawl. Rigging cost for two boats runs about $6-12,000 . . . .



. . . . **Nine HYDROPLOT systems for automatic acquisition of hydrographic survey data**, will be installed aboard various NOAA ships and launches, reports the Department of Commerce. Originally designed and developed by NOAA's National Ocean Survey, HYDROPLOT's specialized equipment greatly reduces nautical chart production time . . . .

. . . . The Gulf of Mexico will be **the first area with computerized nautical chart data** when NOAA's automated hydrographic data bank begins operation in about a year. Data automation for all of NOAA's 971 nautical charts is set for 1980 . . . .

[1]Canadian Pair Seining: Off-season Source of Income for New England Lobstermen? Marine Fisheries Review 36:7, p. 45.

. . . . **Synopses of blue and white marlin, and sailfish catches** in the southeast Atlantic, Gulf of Mexico, and Caribbean Sea are given in the NMFS' second annual **Oceanic Gamefish Investigations Newsletter.** Fishing effort and time of day are compared with catches, and historical fish weight and distribution data are noted. Fishing tournament results, Skylab Oceanic Gamefish Project fishing details, and western Atlantic billfish catches by the Japanese longliners (1957-1971) are listed. Free copies are available from the Southeast Fisheries Center, NMFS, NOAA, 75 Virginia Beach Dr., Miami, FL 33149 . . . .

. . . . **New Executive Director of the Marine Technology Society is Mrs. Elizabeth M. (Libby) Wallace**, the Society reports. She has been Executive Director of the New York based Shellfish Institute of North America for the past 10 years . . . .

. . . . **Part of Oregon's Coos Bay will become a natural field laboratory** under NOAA's first estuarine sanctuary acquisition grant, $823,965. Limited public recreation and oyster farming may be permitted as researchers monitor changes, assess human influences, seek baseline ecological data, and determine the area's carrying capacity . . . .

. . . . **Chlorination substantially increases sewage toxicity to salmon** from primary treatment plants reports the International Pacific Salmon Fisheries Commission, New Westminster, B.C. Effluent from a secondary treatment plant, where chlorine was removed in a lagoon, was found non-toxic for exposures as long as 26 days in direct exposure, however . . . .

. . . . **South Carolina's estuarine system survey has been extended another year** by the Coastal Plains Regional Commission, *The Marine Newsletter* reports. Baseline data on the biological, chemical, and physical nature of major estuaries is sought by Wildlife and Marine Resource Department biologists . . . .

☆ GPO 697-577

THE 1972 ECONOMIC CENSUSES

Early in 1972...we asked the business community's help in providing us with the basic information about its business activities during the year 1972. The facts were requested so that we, in turn, could provide YOU with the data from various economic areas! NOW - the results are in! They're being analyzed...fed to computers...and published for YOUR use....YOUR needs...YOUR advantage in keeping up with the latest trends in the business and industrial worlds.

There are hundreds of reports coming off the press as fast as figures are tabulated.

Get the facts! Have your name placed on our mailing lists to receive a copy of the Publications Programs and publications order forms (free of charge), which describe the contents of the reports and the scheduled release dates. Please fill in your name and address, check the appropriate boxes below, and mail to:

Publications Distribution Section
Social and Economic Statistics Administration
Washington, D.C. 20233

(please detach along this dotted line)

Please add my name to your *order form* mailing lists for the following publications:

- ☐ **Retail Trade**
- ☐ **Wholesale Trade**
- ☐ **Selected Services**
- ☐ **Manufactures**
- ☐ **Minerals**
- ☐ **Construction Industries**
- ☐ **Transportation**
- ☐ **Enterprise Statistics**
- ☐ **All Economic Censuses**

(please type or print)

Name ____

Street Address __________________________________

City, State, and ZIP Code ______________________________

U.S. DEPARTMENT OF COMMERCE • Social and Economic Statistics Administration • BUREAU OF THE CENSUS

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS STAFF
ROOM 450
1107 N.E. 45TH ST.
SEATTLE, WA 98105

OFFICIAL BUSINESS

FOURTH CLASS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-210

U.S.MAIL

MFR XEROX300XC R 1
XEROX UNIV MICROFILMS
SERIALS DEPT
300 N ZEEB RD
ANN ARBOR MI 48106

AMERICAN REVOLUTION BICENTENNIAL
1776-1976